lume 10 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Contents

FEEDING FIGHTERS ON THE FIRE LINE

R. H. Blood

Administrative Assistant, Cleveland National Forest

For some time we have felt the need of some method of messing in fire camps that would avoid the long tiresome trek into camp for men who had spent long hours in suppression work; the turmoil and confusion that exists in camp where several hundred men are resting, eating, or changing shifts; the garbage disposal problem; the transportation from headquarters of heavy camp equipment and food supplies; chronic difficulties with cooks and kitchen help; heavy losses of perishables, due to lack of proper refrigeration; etc.

This season we decided to run an experiment during our guard school, in which men could be furnished hot food on the fire line. They could then stay in their assigned locations day and night without returning to camp for food or rest periods.

Through the local military we obtained considerable information on the method employed in feeding field groups during the war and during manuevers. From Camp Pendleton we borrowed 10 Aer-

Food carrier with utensils separated; utensils assembled and ready to be placed in carrier; and the 10-gallon and 1-gallon thermos jugs for liquids.

Void food carriers, which are, in effect, thermos cans containing 4 trays or utensils approximately 11½ inches wide by 6 inches deep. The outside measurements of a can are 27 by 14½ inches, and the total weight empty is 52½ pounds.

These cans will hold food for approximately 50 men and the manufacturer recommends that food be placed in the containers at approximately 180°, and liquids at 200°. The 4 utensils are prepared to handle separately meat, potatoes, a vegetable, and gravy. We had hoped to try a much smaller unit, sufficient to serve 10 to 15 men, but were unable to obtain these from Camp Pendelton. However, there are such utensils on the market. The same is true of the coffee thermos. The type used was 10-gallon size, from which 1-gallon thermos jugs were filled. We are trying now to locate a 5-gallon size.

For the guard training set-up we had a total of 80 men and Fire Control Officer Stevenson desired to feed these in groups of 10 on the fire line. With the larger cans, this made it necessary to reduce the potential capacity of each container by about 80 percent, which had the effect of decreasing the period during which food in the master container would remain hot.

We obtained prices from a local caterer covering dinners of chopped steak, hamburger steak, roast beef, Swiss steak, etc., with mashed potatoes, a green vegetable, and cake. Coffee, as stated, was furnished in 10-gallon urns and distributed to the individual crews in 1-gallon jugs. The breakfast menus included sausage and eggs, bacon and eggs, or ham and eggs, with potatoes, rolls, butter, and coffee. The lunch was an ordinary box lunch containing meat and jam sandwiches and could be obtained with cold milk, handled in the same manner as coffee. The prices asked for these meals were $1 for dinner, 75 cents for breakfast, and 60 cents for lunch.

For experimental purposes, on the second day of guard school, we delivered breakfasts to the camp at approximately 7 a. m., and in the same load sent the lunches and supper for that night. The evening meal, with coffee, was served some 12 hours after preparation and at that time was sufficiently hot. With smaller containers, or with larger crews that would permit the filling of each utensil to capacity, food would remain hot for even a longer period.

Fire Control Officer Stevenson reports as follows on the fire line feeding: "The guard training program included considerable actual line construction and the 80-man crew was broken down into small groups with crew bosses or sector bosses and instructed to remain at their assignments until relieved. Food was delivered to the end of the road in thermos containers. These containers along with knives and forks, paper cups, plates and spoons, and a small thermos of coffee or milk were delivered by pickup or weasel to the various crew leaders. Each crew boss served his own men and within 5 minutes the 80 men had been served. They had finished eating within 25 minutes. Everyone was completely satisfied with quantity and quality of food.

"A base camp was established for the sole purpose of providing a distributing point for tools and food. Camp overhead was reduced to the absolute minimum and no time was lost in bringing men into camp for meals. One man in a jeep or weasel can deliver food to a great number of men that would ordinarily have to be walked to and from

the fire line, or fed exclusively on box lunches. When the camp broke up there was no kitchen equipment to dismantle or clean, no dishes to wash except knives and forks, no garbage to dispose of, and no waste of surplus perishables. The overhead is given an opportunity to get closer to their men by feeding them and by remaining with them throughout the entire period of their employment. On an actual fire, of course, the helicopter should do an excellent job in delivering these canned meals to the men on the line.

"In future, two small units will be set up in the main camp site for heating food that is left over and to provide hot water for washing knives and forks. The latter items are the only draw-back to the operation and we will try to work out a system so that the men will not have to carry their own cutlery."

On July 1 our Pamo Hot Shot Crew was organized and sent to camp. After arrival it was found that neither the stove nor the refrigerator would operate. Repairs would take several hours. Under these conditions, we would ordinarily have to bring the 40 men back to town for food. Instead we sent from here one can containing hot supper and another with breakfast for the following morning.

On July 8, 1948, the Barrett Dam, the Rollin Hills, and Viejas No. 3 fires broke out on the Descanso district and over 4,000 hot meals were served by the method outlined above. Meals were transported 45 miles from San Diego by truck and the men were served on the line, about 20 percent of the deliveries being made by helicopter. In many cases the food had to be delivered in the 1-gallon paper containers recently received, because the master containers were too large for serving the crews of 8 to 10 men spotted at various locations on the line.

It is felt also that the regular meals should be supplemented by cold juices (grapefruit or orange juice) which can also be delivered to the line in thermos containers. We will continue to use milk with lunches, preferably in pint or half-pint paper containers. These containers can also be stored and kept cold in one of the large 10-gallon thermos. To the hot meal we plan to add a cold vegetable salad which can be kept cold either in one of the containers or in a paper carton prepared for that purpose by the Polar Ice Co.

Here in the office we find that at the end of three large fires on which several hundred men were employed our vouchering for food supplies can all be cleaned up in a matter of hours instead of the previous long-drawn-out job of rounding up purchase orders, invoices, etc., from the dozen or more grocery and meat firms. An equal amount of time was saved, of course, in not having to phone in and confirm orders to the large number of grocery stores and meat markets that we are forced to purchase from when fires occur at night or over week-ends. Without having any definite figures to go on, I would say that our actual meal costs, considering regular kitchen help, and other items, has been reduced by something like 50 percent through this method. The intangible savings are impossible to compute.

Food for 500 men, with coffee, milk, and juices, can be handled easily in the bed of an ordinary pickup.

CINDER HILLS—A SPECIAL FIRE CONTROL PROBLEM

K. O. Wilson

Fire Control Officer, Coconino National Forest

Within the northeast corner of the Coconino National Forest lies an area roughly three townships in size which is locally known as the "cinder hills." It is composed of rolling hills over which a layer of black cinders was deposited some 900 years ago by numerous volcanic cones within the area. The cinder particles average about the size of peas, are very porous, and form a layer a few inches to several feet deep. Ground cover is composed chiefly of scattered ponderosa pine, a few grasses where the cinder deposit is thin, and a sparse growth of shrubs on the north slopes. The area is characterized by patches of barren cinders which form an irregular pattern among the trees. These patches vary in width from a few inches to several hundred feet.

Until recent years these cinder hills have been cataloged as "too scattered to log," and what little logging was done on the area was confined to small tracts which supported the heavier stands. Recent heavy demands on the lumber market have caused this area to be logged rather extensively which has resulted in large areas of almost perennial slash. We use the word "perennial" because the slash deteriorates very slowly because of an almost total absence of moisture-retaining qualities in this type of formation. Extremely high surface temperatures coupled with a high infiltration rate cause moisture to disappear almost as rapidly as it falls. High burning conditions are often in evidence only a few hours after a heavy rain. Add to this a high lightning occurrence, gale force winds, and a high risk from tourists, wood haulers, and loggers, and you have a set of conditions which a fire control officer sees only in his worst nightmares.

On a windy day a fire once started in this area quickly reaches uncontrollable proportions. To put a corral line around a fire in cinders is a relatively simple operation (two RD–6 bulldozers built over 7 miles of line around a large fire this spring in less than 3 hours). To hold the fire within this line is quite another matter. Each fire follows a definite pattern, i. e., the first 24 hours the flashy fuel goes; then the fire starts to dig in. The dead windfalls and stumps are usually consumed within the first 48 hours. After the stumps are gone the fire then starts down each individual root in the root system. The porous nature of the cinders allows enough air into the ground to permit the roots to smoulder very slowly. A fire in 1947 was still burning 62 days after it started. This spring a similar fire started on the 7th of April and was still burning on the 15th of May. A burned area may go several days without showing any sign of smoke and then suddenly on a windy day be smoking in many places.

The obvious question is: "Why don't you put the fire out just like you would any other fire?" This would indeed be a tough assignment. In the first place the nearest water supply is 25 miles away, a prohibitive distance to haul. In the second place there is no mineral soil, except the cinders with which to work. In the third place, after the first 48 hours the fire has gone underground and is extremely difficult to find.

The past two seasons we have been experimenting with various techniques of control, some with disastrous results, and others with varying degrees of success. First we tried just building a control line, allowing the fuel within the line to burn undisturbed, maintaining a patrol until the fire was declared out. This fire had to be patrolled for over 2 months. The next fire we used bulldozers to bury all burning heavy fuel within 100 feet of the line under 3 or 4 feet of cinders. This proved disastrous. The fuel continued to burn, allowing the cinders to fall into the cavities resulting from the consumed fuel, and 12 days after this fire started it suddenly came to life on a windy day and, after crossing the control line in a number of places, more than doubled its original size in one afternoon.

Two valuable lessons were learned from these two experiments. The first, don't let the fire go underground, and the second, cover fuel with cinders only to prevent the wind from spotting in the daytime and uncover at night, allowing the fuel to burn as much as possible.

After the "cover-up" method failed, resulting in a serious breakover, we used an entirely different technique developed from the lessons learned on the first two trials. As soon as the bulldozers had completed the control line we immediately put them to work pushing all heavy fuel at least 300 feet back into the fire from the fire line, and rooting out all of the burning stumps within the same strip before the fire had time to go underground. This was accomplished with three bulldozers within 36 hours after the fire was corraled. In the meantime mop-up crews were patrolling the fire line and the cleared strip, picking up what the bulldozers missed. Other patrol crews were covering a quarter-mile strip outside of the fire line and picked up several small spots. Still other crews were working inside of the cleaned bulldozer strip, digging out stumps and chopping the fire from burning logs.

Seven days after the large break-over we have just described occurred, a strong wind caused the fire to make another break and burn an additional 60 acres. We employed the same technique on this smaller break that we had used on the larger, except that we covered the entire area with bulldozer mop-up, rooting out every stump within the area. This proved successful, and the fire was finally declared out 16 days after the last break-over.

An interesting sidelight on this series of fires was the use of Navajo and Hopi Indians recruited from the vast Navajo-Hopi reservation which lies directly north and east of the cinder hills. Many of them saw the smoke from the fires and rode many miles horseback to report in to their villages and trading posts. Some were transported by truck from as far as 200 miles out on the reservation.

We found them to be very well adapted to mop-up work as long as they are supervised by other Indians. Living under fire camp conditions and sleeping on the ground is their normal way of living. Dis-

cipline was excellent. The crews of approximately 20 men each, with Indian leaders, moved almost with the precision of trained soldiers throughout the camp and fire areas. The crew leaders did a remarkable job of keeping the men away from the camp area when they were off shift and moved their men through tools, timekeeping, and the kitchen with a minimum of time and confusion. Their appetites, aggravated by months of lean living, were enormous. They showed a particular fondness for bread and sugar. As soon as a camp boss learns he is going to have Indians to feed he immediately doubles the order on these two items.

We asked the leaders if a small crew of the Indians would be willing to stay with the fire, patrolling and mopping-up until the fire was out. This turned out to be a question of great importance which called for several council fires burning far into the night while the Indians sat cross-legged and blanket-wrapped before deciding who should remain. All accepted the final decision without question.

By using Indians for the long, tedious job of living with these cinder-hills fires until they are out, we are hopeful that we have struck on a solution to the ever-present manpower problem after control.

WEST VIRGINIA EPISODE

S. H. Marsh

Regional Forest Inspector, Division of State and Private Forestry, Region 7, U. S. Forest Service

The day before Christmas jovial hard-hitting Jim Fischer, district forester of the Pocahontas district for the West Virginia Conservation Commission, called in his men, thanked them for a job well done, and told them they could go home for the holidays. It had been raining for several days and Christmas Eve it was "spitting" snow. Everything looked safe and buttoned up for a holiday.

Jim, a newcomer on the district, had planned to gather up his family which was scattered among his kinfolk, and shake down into his new quarters. His assistants all had their own plans and looked forward to a breather, for it had been touch and go for several weeks. They were also looking forward to wild turkey and the accessories that go with Christmas in West Virginia.

It was a happy group. They jokingly recounted some of the tight spots they had gotten into, and out of, successfully or otherwise, kidded the holder of the record for the biggest fire and with ceremony cut off his shirt tail and tacked it up beside the dispatcher's map. Then all went their separate ways, with pride of accomplishment written in every line of their smoke-stained faces. Their record showed they were good. In 1 year they had fought the notoriously "hot" Pocahontas district, a troublesome area for a generation, into second place for low number of fires and area burned.

Christmas day dawned bright and clear, with a whisper of a wind. The next day, December 26, the wind rose almost with the sun and slowly gathered speed till sundown. When it continued through Saturday, December 27, it was enough to arouse the suspicions of Zara Osborne, the chief clerk, who from long experience had learned what even an apparently insignificant wind can do around the hills of West Virginia.

Was that the faint odor of smoke she smelled as she emerged from a store? She decided to find out and dashed to the office to don the radio harness. Bang, bang, bang, the reports came as fast as she could write them down until she had a list of 14 fires. Quickly deciding that this was more than a one-woman job, she spread the alarm and in a matter of minutes by radio and wire she had men racing over the hills to man their stations. The packages piled so unceremoniously on the desk when she arrived in the office remained there until early Sunday morning when all fires were manned and she was relieved.

As State Fire Chief Mullins, District Forester Jim Fischer and District Fire Chief Costilow converged on district headquarters at Logan, their radios sputtered instructions; and as key points were

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manned, information began to come in, at first in a trickle, then in considerable volume. By the time they reached Logan headquarters, the fire pattern and all its implications had begun to unfold and take shape, and it was clear that trouble, plenty of it, was brewing in the four-county "hot spot" of the district centering in Mingo, the seat of a number of bloody mine wars of a generation ago.

It was not a pretty picture. It appeared that everyone with incendiary proclivities in Mingo County had selected this particular time to put them into practice. Smokes were being reported in the most inaccessible and out-of-the-way places. Wayne Shannon and Lyndell Hockman, the Mingo County protectors, with their local crews were hitting the fires hard. But it soon became evident they would need more help and relief crews as they strung out their men and pinned them down on mop-up.

After State Forester Sayers had make a quick survey by plane, calls were sent to neighboring districts for help which promptly rolled in just as Mingo began opening at the seams and the flood of incendiarism slopped over into McDowell, Wyoming, and Logan Counties.

At this point the plight of the protection organization was related to "Scotty" Harris, chief of the law enforcement division, who promptly dispatched 20 officers, led by "Tiny" Stewart (6 feet 4 inches tall), to help round up recalcitrant or reluctant fire fighters and render such other aid as might be needed. The enforcement officers were paired with fire bosses, and the manpower shortage was dissolved in spite of the prevailing holiday reluctance to fight fire. New fires were promptly and adequately manned. Old fires were fought to a finish and mopped up without break-overs.

From his master chart at headquarters, District Forester Fischer knew what crews were on what fires, when they went on duty, when they were due to be relieved, and just who would relieve them, and he saw to it that the relief kept rolling on schedule. Timing was well-nigh perfect and every man was doing his share of the work.

By Wednesday, December 31, the situation was well in hand. Every fire was covered. Those that had not been mopped up were under control. Then it rained and promptly put an end to the fires. The final score was 50 fires that burned a total of 2,600 acres.

Since the protection of West Virginia's forests was undertaken it had always been well nigh impossible to secure a conviction for a fire law violation in Mingo County. But Jim Fischer and his men either did not appreciate the significance or implications of such a tradition or were just not impressed by the historical events leading up to the fires. At any rate, when it became evident that there would be a respite from the fires, the fire bosses and law enforcement officers gathered to piece together the bits of evidence they had picked up and to discuss the next move.

The next day, New Year's, they teamed up again, a forest officer and a law enforcement officer, and began a systematic combing of the Mingo County hollows for more evidence to back up the few leads they had secured. Five or six teams usually converged on a mining camp or village, interviewing every member of each household and everyone they met on the streets or roads. Having thoroughly canvassed one hollow they proceeded to the next one, until all suspected hollows in Mingo County had been covered.

Gradually, evidence began to pile up, and whenever it pointed unmistakably to a suspect, warrants were sworn out, witnesses summoned, and prosecutions began. The score for Mingo was 25 arrests, 25 convictions. Four of the convictions were on felony charges carrying 1 year in jail. A number of cases were still under investigation this spring in Mingo, as well as in the other counties where the same procedure was followed, and other arrests have been made.

Opinions may vary concerning the efficacy of law enforcement as a fire-prevention measure but the record of the following season (spring of 1948) showed a remarkable, almost unbelievable improvement. Fires occurred at a rate of only 0.19 per 1,000 acres protected and the "burned area" reduced to 0.005 percent of the area protected. Apparently some people had learned, or had been persuaded, that "Forest Fires Don't Pay."

STRETCHER CARRIER

H. K. Harris

Forester, Region 1, U. S. Forest Service

The stretcher carrier has been developed for use of the air rescue squad in Region 1. It requires two men to propel and balance the carrier along trails or in open country.

The patient is carried in a modified Stokes litter, developed by the Army. This litter is supported by a single rubber-tired wheel. The wheel is equipped with a 6.00 by 6 airplane-type tire which has only a few pounds of air. This tire absorbs much of the roughness on rocky trails. The wheel has also been equipped with a brake to retard the carrier on steep slopes. A "wishbone" fork, constructed of aluminum tubing, is hinged on the bottom of the litter and supported by two rings of heavy bungee shock cord. The fork can be adjusted to give proper balance and raise or lower the litter to the best height for ease in handling. A shoulder harness is provided; it is adjustable and has slings made of webbing to carry a large share of the load. Each man uses his arms largely for balance of the carrier. The handles are removable and the carrier folds into a bundle little larger than the Stokes litter. It can be packaged for dropping and assembled for use in a few minutes.

The stretcher carrier was thoroughly tested by members of the air rescue squad, who have had experience in carrying injured men out

to car or plane transportation. The crew took turns riding and pushing over rocks, logs, snow banks, and downhill through dense brush and every form of cover obtainable. They reported the carrier satisfactory. A comparison was made of riding comfort when the stretcher was wheeled over rough rocky trails and when carried over the same trail. Surprisingly the "patient" said it was more comfortable when wheeled over the rocks than when carried.

The carrier has been adopted as part of the regular equipment of our air rescue squad, and is kept ready for immediate use.

Drawings, photographs, and material lists of the carrier are available to other regions or interested agencies. Without the Stokes litter (obtained from the Army) the cost is approximately $75 for materials and labor.

Comparative Performance of D–6 and D–7 Caterpillar Tractors Equipped with Hydraulic Angle Dozers.—E. D. Report No. 13 was issued April 1948. Tests, conducted by the Arcadia Fire Control Equipment Development Center, covered not only work output in constructing fire lines, but also speed of transportation, load limits, etc., which must be taken into consideration in determining the size of tractor best suited to given conditions.

These tests were made primarily for the purpose of comparing performance of the D–6 and D–7 tractors. They were made under ideal conditions, so results approach the maximum rates rather than average. It is believed, however, that the information can be of great value by scaling down anticipated performances in accordance with conditions encountered.

The D–6 tractor compares favorably with the D–7, especially for fire line construction in brush-covered country. However, additional tests in timber country are necessary to complete the comparison. The comparative tests made with the D–6 and the D–7 gave the following results:

1. The D–6 may be transported by truck more rapidly than the D–7, particularly over mountain highways. The saving in time on this type of highway for the D–6 over the D–7 amounted to almost 1 minute per mile, or about 26 percent.

2. Very little difference in speed was observed in walking the two tractors on standard Forest Service truck trails.

3. In grade ability, with the blade raised, there was very little difference between the D–6 and the D–7. It might be well to point out that both tractors have considerably less climbing ability in reverse than in forward gear.

4. There was practically no difference in the cross-country travel performance of the D–6 and D–7 on side slopes with the blade raised.

5. In the construction of fire line through medium and heavy brush and up and down grade, the D–7 produced approximately 20 percent more single pass line on all slopes than the D–6. On a square footage basis, the D–7 constructed 44 percent more fire line per unit time.

In order to produce fire line at the maximum rate, the D–6 and the D–7 should work downhill on grades of 20 percent and over, even though it may be necessary to walk the tractor up the slope to permit downhill construction.

6. When cutting first from one bank and then from the opposite, it was found that, for all practical purposes, greater production was possible by changing angle of blade rather than using a straight blade.

7. In common excavation work the D–7 moved 150 cubic yards per hour while the D–6 moved 111 cubic yards, indicating 35 percent more output for the D–7. (The present D–7 is comparable to the old RD–8, and the D–6 to the old RD–7.)

The D–6 tractor costs less than the D–7 and can be transported faster by truck.

The D–7 tractor constructed per unit of time an average of 20 percent more linear feet of single pass fire line, 44 percent more square feet of fire line, and 48 percent more linear feet of fire line on 30 percent side slope. Its fire line was cleaner on single pass construction; and it excavated 35 percent more cubic yards per unit of time.

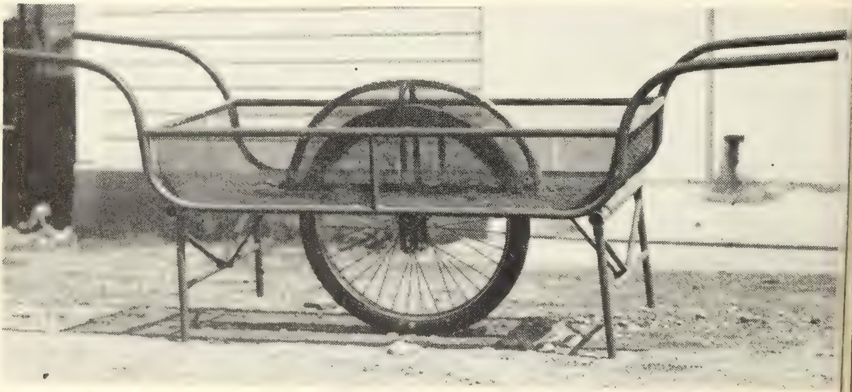
A limited number of copies of E. D. Report No. 13 are available in the Division of Fire Control, Forest Service, Washington, D. C., for distribution to concerns keenly interested in the subject.—DIVISION OF FIRE CONTROL, *Washington Office, U. S. Forest Service.*

DUFFLE CARRIER

REGION 1

U. S. Forest Service

The duffle carrier is a collapsible, single-wheeled frame for use in transporting equipment along a trail. It is arranged so it can be folded into a compact bundle for dropping by parachute. The carrier weighs 38 pounds and preliminary tests indicate it will carry 150 to 200 pounds.



During the winter, as part of the fire suppression studies, we analyzed the smoke-jumper fires to determine the mileage of cross-country travel and trail travel from the fires to the nearest road or airfield. The difficulties of this travel were also cataloged as uphill, downhill, or level, and averages determined. Our reason for this analysis was to study the problem of returning smoke-jumper equipment by means of Iron Mule or hand-propelled carrier and thus eliminate in certain areas the need to maintain pack stock and pickup men. These studies showed that the duffle carrier has good possibilities.

If an emergency does not exist, equipment in many areas would be returned to road or airfield by the smoke jumpers themselves, even though pick-up by helicopter becomes feasible.

A similar type of duffle carrier has been built for the Bitterroot Forest. Its purpose is to carry a chain saw along trails for maintenance work. Several other forests have also requested a carrier of this type.

Plans for construction of the two carriers illustrated may be obtained from the U. S. Forest Service, Missoula, Mont.

Calcium Chloride Prevents Freezing of Stored Water.—The following tabulation from Marks Mechanical Engineers' Handbook may be of interest to those who have the problem of providing stored water for fire protection at buidings during periods of freezing weather. When 100 pounds of water and solution contain a given weight of calcium chloride the freezing point of the solution is as follows:

Calcium chloride (pounds)	*Freezing point (° F.)*	*Calcium chloride (pounds)*	*Freezing point (° F.)*
6	28	20	—1.0
8	24.2	22	—7.3
10	21.4	24	—14.1
12	18.2	26	—22.0
14	14.4	28	—32.0
16	9.9	30	—46.0
18	4.7		

If iron barrels are used to contain the water and solution, they should be painted inside with hot tar to prevent deterioration due to the calcium chloride.—DIVISION OF ENGINEERING, *Washington Office, U. S. Forest Service.*

A SLIP-ON TANKER FOR PICKUP TRUCKS

H. M. White

Division of Fire Control, Region 6, U. S. Forest Service

The unit described and illustrated in this article was designed to fill the need, in the North Pacific Region, for a light slip-on tanker that could be hauled in a one-half-ton pickup or larger truck and quickly removed when the truck was needed for other hauling. The main features of the design are:

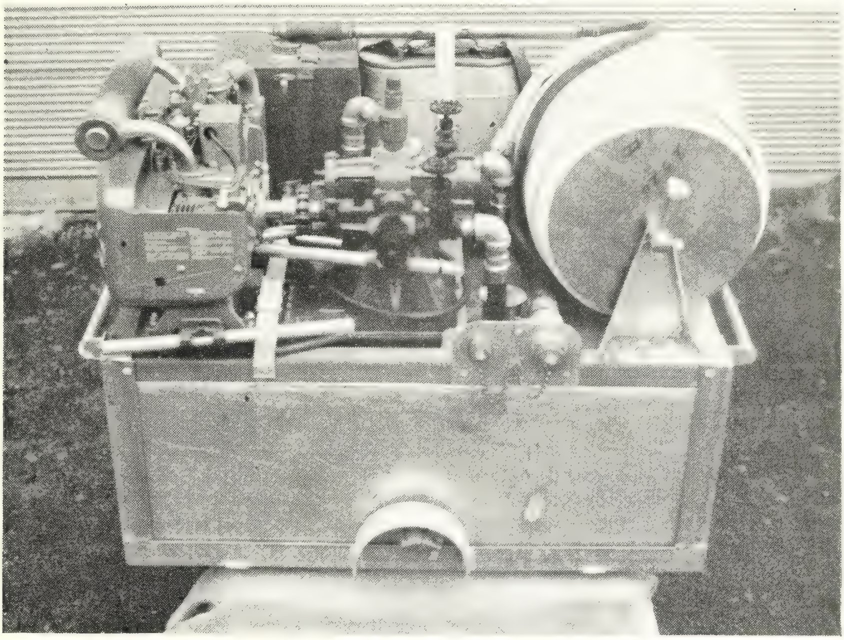
1. The unit is self-contained, the pumper and all accessories being mounted on the top frame.
2. Weight of tank, frame, reel, tool box, piping, and mounting brackets was kept to the minimum by using aluminum alloys. Even the bolts are aluminum.
3. A standard portable pumper, gasoline tank, and suction hose are mounted in such manner that they can be quickly freed for carrying to a water source that may be near a fire but to which the truck cannot be driven.
4. Provision is made for securing the unit in the pickup with clamps attached to the flareboard. The clamps are adjustable for different pickup body widths.
5. One-inch cotton-jacketed rubber-lined discharge hose, rather than rubber hose, is provided to keep the weight down and at the same time permit reasonably high pressure. This hose is carried on a simple reel (dead), because a reel takes less space and is considered more practicable otherwise than a basket for mounting on a small tank. The hose is coupled in three 100-foot lengths, so that if less than the 300 feet provided is needed to reach a fire it will not be necessary to unreel the full amount.

Brief descriptions of the principal parts of the unit are as follows:

Water tank.—Outside dimensions, 46 by 31 by 17 inches, with two baffles across the 31-inch dimension, three 1½-inch drain plugs in the bottom, and a ¾-inch drain cock at rear. Material is No. 52–S aluminum sheet, 0.125 inch thick, except baffles which are 0.092 inch. All joints are welded.

Frame.—Material is No. 61–S extruded aluminum. The sub-frame and corners are $^{3}/_{16}$- by 2½- by 2½-inch angle, and the skids ½- by 1½ by 2-inch H-bar. Joints are welded. The top frame is ¼- by 2- by 2 inch channel. It is bolted to the corner uprights so that the tank can be removed for repair or cleaning. The pumper and other things are fastened to the top frame, the handles, reel, tool box, and bracket being bolted.

Reel.—The ends are No. 24–ST aluminum, 15¾ inches in diameter. The shaft is ¾-inch aluminum water pipe, and the core six ⅝-inch No. 24–ST aluminum rods, 22 inches long, set in a 5-inch circle.



Rear view of slip-on tanker in position for sliding into pickup truck.

Tool box and brackets.—These items were made of scraps left over in cutting out the tank. The tool box is 18 by 9 by 4 inches. It carries lugs on top for the fuel tank. Suction hose brackets, at front corners of top frame, are spaced for 4-foot sections of suction hose, and will hold five. A back-pack can is carried in a bracket behind the suction hose. The can and fuel tank are secured with light web straps.

Pumper.—A rotary gear pump, driven by a 10 horsepower, 2-cylinder, 4-cycle, air-cooled engine. Capacity is 35 gallons per minute or more at 250 pounds per square inch. Lugs on the frame keep the pumper from sliding and a heavy web strap holds it down. There is very little vibration. Other kinds of portable pumpers could be used, of course, with some changes in the mounting.

Piping.—To provide for quick detachment, special cross fittings were made, with swivel connections for attachment to pump outlets. Lines to tank and discharge line to outside are made with rubber hose. All metal pipe and fittings, except certain nipples, are aluminum water pipe. To free the pump, the hold-down strap is released and the pump outlet connections uncoupled. The hose from relief valve to tank may be disconnected or left on, as desired. The relief valve is installed in the pump housing. The two gate valves shown control suction and discharge lines to tank, both 1-inch.

Cover.—A waterproofed canvas cover is provided, to fit over the entire unit. It is secured with a draw cord just below the top frame.

Hold-down clamps.—A metal clamp, or wide hook, was made to fit over the roll on the flareboard of the pickup body. It is attached to a 2½-inch heavy web strap, which is passed over the unit handle

814289—48——3

and buckled. Two of these clamps are required. Since the unit is higher than the flareboard on most pickups, the pull is downward. On the Dodge power wagon, arrangements will be made to attach the clamp below the flareboard.

Weight.—The complete unit, dry, with all accessories, weighs approximately 475 pounds; the pumper alone, without fuel tank, 160 pounds.

Cost.—Final figures are not available as yet, but the average cost per unit is expected to approximate $1,200. The pumper, with four 4-foot sections of suction hose, strainer, and necessary tools cost $467.

Detailed plans of this unit are available in the Regional Forester's Office, U. S. Forest Service, Portland, Oreg.

Printing Maps on Fire Finder Disks.—In an effort to improve up the method of mounting paper maps on metal fire finder disks, a procedure has been developed to print maps of any area directly upon the painted surface of any metal disk by the use of a sensitized emulsion containing carbon particles as a pigment. The metal fire finder disks are first cleaned with steel wool or emery cloth then sprayed with 2 coats of flat ice-box white synthetic enamel. When dry, thoroughly sand side of disk to be used with very fine sandpaper. The disk is now coated with the emulsion described below by using the multilith whirler in the same manner as if multilith plates were being coated.

The emulsion is prepared from two solutions. Solution 1 consists of 3 ounces of egg albumen (flake) in 20 ounces of water. This is suspended overnight in a cheesecloth bag and strained. Solution 2 is 1 ounce of ammonium bichromate in 4 ounces of water. Combine solutions 1 and 2 and add strong ammonia water (approximately 28 percent Bohme) until emulsion turns straw yellow. This quantity (20 ounces) of emulsion will coat two disks.

To each 10 ounces of resulting solutions add 1 tube of artists' lampblack water color paste. One teaspoon of Peerless transparent water color will further improve quality of final print. It is important to dissolve pigment thoroughly and then strain emulsion. Also move air bubbles from emulsion by straining through cheesecloth before coating disk in whirler.

A Kodalith film negative is prepared for the area necessary to cover the disk and then exposed with an arc light while in a vacuum frame for a period of approximately 10 minutes. Disks are then immediately washed in water; a piece of cotton is used to clear off excess emulsion not set by light exposure. The background should be clear and white, with map details a good strong black.

When disks are dry, spray 2 coats of clear lacquer on the surface. This will insure resistance to weather and water.

While this process is being used for the first time this season, it is reasonable to believe that this type of print should not fade in sunlight since the pigment coloring is lampblack which is composed of very small carbon particles.—BURTON D. ANDERSON, *Chief Draftsman*, and EARL A. JARBOE, *Supervisor, Duplicating Unit, Region 3, U. S. Forest Service.*

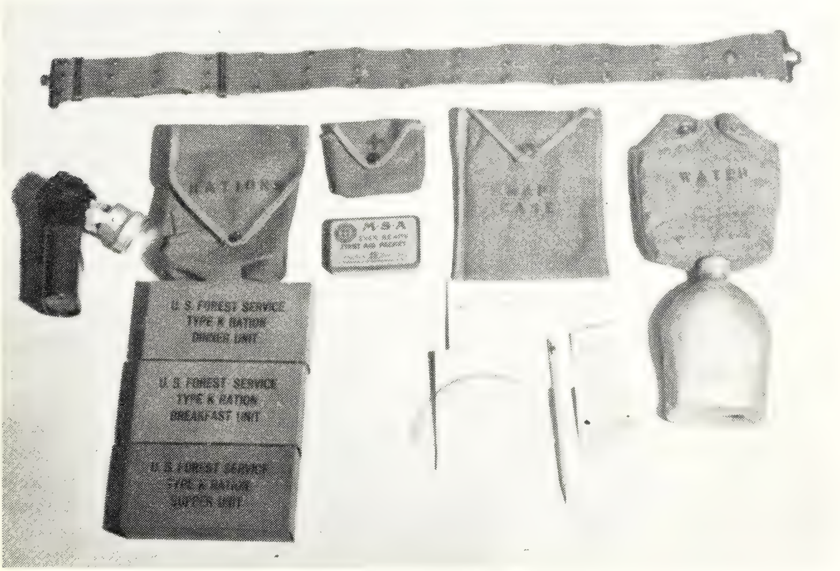
FIRE FIGHTER'S BELT

GLENN A. THOMPSON

Fire Control Staff Officer, Payette National Forest

In central Idaho fire fighters often walk many miles to interior fires without accompanying pack facilities and must carry the means of individual support for a 24-hour period. The equipment for carrying must be the best to allow walking to and fighting a fire. The knapsack has been used for many years but the individual was always forced to leave it whenever he began work.

The fire fighter's belt was selected as an all-purpose carrying device that would permit the individual to be self-sufficient not only during the initial attack period but throughout each work shift thereafter. The smoke jumpers have used these belts for the past year and find that they fit their needs very well.



Fire fighter's belt with packets and items detached. Any combination of these and other items can be quickly assembled.

SOUTH DAKOTA'S JEEP TANKER

Harry R. Woodward

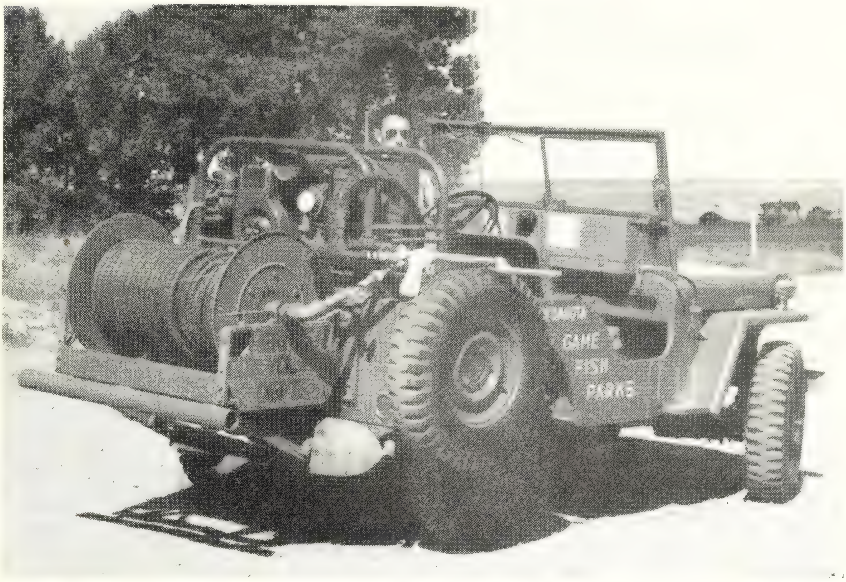
State Forester, South Dakota Department of Game, Fish, and Parks

Since the war many fire control organizations have made various developments in the use of the jeep as a fire fighter. South Dakota has had such excellent success that our particular developments bear some discussion.

In the first place there were no facilities in our organization to provide housing and manpower for jeep units, and yet we knew that if we could get some mobile units strategically located that our fire problem could be largely solved. This speculation resulted in cooperative agreements with various fire departments in the Black Hills area. Under these agreements the State furnishes a jeep equipped with two-way frequency modulation radio to the fire department. In return, the fire department agrees to equip it, house it, maintain it, and go to any fire when called upon by the State. The State reserves the right to approve the type of equipment to be installed.

When the jeeps were requisitioned, it was specified that they be furnished with heavy duty (11-leaf) springs, and 15-inch wheels with 7:00–15 tires to help in carrying additional weight. Also specified were bumper weights to help distribute weight and the hot climate (oversize) radiator to help cool the motor on long tough pulls or long periods of idling. In addition to these features, we installed heavy-duty generators capable of producing 65 amperes at idling speeds. This generator maks it possible to operate the radio over long periods by just keeping the motor idling. A siren and the radio, a 50-watt transmitter, were also installed. The illustration shows a typical installation for the Link radio in a heavy steel box bolted to the body just above the dashboard. Installations on other units include both the Motorola and General Electric types.

The remainder of the equipment was purchased by the fire department, in most cases with county aid. First of all a heavy gage metal tank was custom built to just fit into the box of the jeep. Capacities of these tanks varied from 85 to 100 gallons. On top of the tank a Bean 101–F portable fire fighter was mounted with wing nuts to permit easy removal so that the pump can be used as a separate unit. We prefer a pump with a power unit separate from the jeep motor to give uniform pressures and to permit the development of a high pressure without overworking the power plant. With this type of pump, we found that sustained operating pressures of 400 pounds gave the best results with a minimum of deterioration to equipment. The live reel shown has proven very efficient and is recommended for all jeep tankers. By using a smaller outside diameter hose (not shown here)



Jeep tanker operated cooperatively by the Hermosa Community Volunteer Fire Department and the South Dakota Department of Game, Fish, and Parks.

which has only one braid and yet can withstand high pressures, we found that we could carry almost twice as much hose by length. The trigger-type fog gun is of great importance in water economy.

Other features included in our jeep units are hand tools of which you see a shovel and part of a back-pack pump. A McLeod tool and a Pulaski tool are carried on the left side and are not shown. An injector type tank filling unit enables you to rapidly fill the tank from a pond or stream. The maximum output of this pump is too slow for normal tank filling purposes. A spotlight and a spare can of gasoline for the pump are not shown here.

There is no evidence at this time that any of these units are over loaded. We have taken the units almost any place a pack horse can travel. They have a record of fast getaway, early control of small fires, and timesaving mop-up. As an example of how practical they are, we converted them to "Ortho" sprayers during our spring campaign against the Black Hills beetle.

MOBILE RADIOTELEPHONE SERVICE ON THE FLAT TOP EXPERIMENTAL FOREST

Herbert A. Yocom

Forester, Southern Forest Experiment Station, U. S. Forest Service

A radiotelephone set mounted on the fire patrol truck has proved a cheap and practical method of reporting fires on the Southern Forest Experiment Station's Flat Top Experimental Forest near Birmingham, Ala.

The set as installed in the truck includes a receiver-transmitter unit, a control unit, and a very short antenna mounted on the truck cab. Power is supplied by the truck battery. The receiver-transmitter unit is in a weatherproof box approximately 28 by 24 by 17 inches in outside dimensions. The control unit is installed on the dashboard. It includes a green light that shows when the unit is switched on, a red light and a bell to indicate when the unit is signalled, and a telephone with a "push-to-talk" button that switches the instrument from listening to talking. The receiver-transmitter unit takes up space in the truck that ordinarily is usable. The control unit and antenna use space that is ordinarily wasted.

A conversation can be carried on directly between the mobile unit and any telephone connected with the Bell Telephone system. Calls from or to the radiotelephone are handled through a regular control terminal of the Bell system in Birmingham, about 15 miles from the Experimental Forest. A special operator at the terminal makes the connection. When the mobile unit is called, the bell rings once and the red "call" lamp lights and remains on until someone answers. The horn can be wired so that it will blow when the unit is signaled. When a call is made from the mobile unit, the caller uses the "push-to-talk" button to signal the operator, who takes the number and places the call.

Radiotelephone has been used on the Experimental Forest through the fall fire season of 1947 and the spring season of 1948. When fire danger is high, the unit is turned on all the time that the patrol truck is manned. During periods of low fire danger, it is usually turned on while the patrol truck is traveling and during the noon hour.

The telephone company representative who demonstrated the unit pointed out that "dead spots" are sometimes encountered, usually in areas lower than the surrounding topography. His instructions were to drive on a short distance and try again. Although the unit on the Flat Top Experimental Forest has been used in the bottoms of hollows 400 feet lower than the surrounding topography, it has always been possible to make calls to and from the unit.

The telephone company furnishes the equipment and service for \$22 per month for local exchange calls. This charge allows for 20 outgoing calls of 3 minutes each. Additional calls cost 30 cents each. There is no charge for incoming calls, but the caller has to pay any long distance costs. There was an installation charge of \$25. The maintenance service, which is furnished by the telephone company at no cost, has been excellent.

The radiotelephone has definite advantages over an ordinary radio communication system. Radio has a higher initial cost and requires special arrangements for maintenance service. Moreover, the radiotelephone is directly tied to the existing telephone system. This does away with the need for stand-by sets and makes it possible for the operator of the mobile set to contact other telephones if the first does not answer.

Radiotelephone as a public service is relatively new. It has been available in Birmingham about 2½ years. At present, it is designed principally for urban areas, and is now in use in some 54 cities throughout the United States. The telephone company plans to expand the service as rapidly as possible. Probably the next step will be to make it available on all main highways. The distance that the service operates satisfactorily outside the urban areas varies considerably with the topography.

814289—49——4

CHALLIS FIRE LINE AND TRAIL PLOW

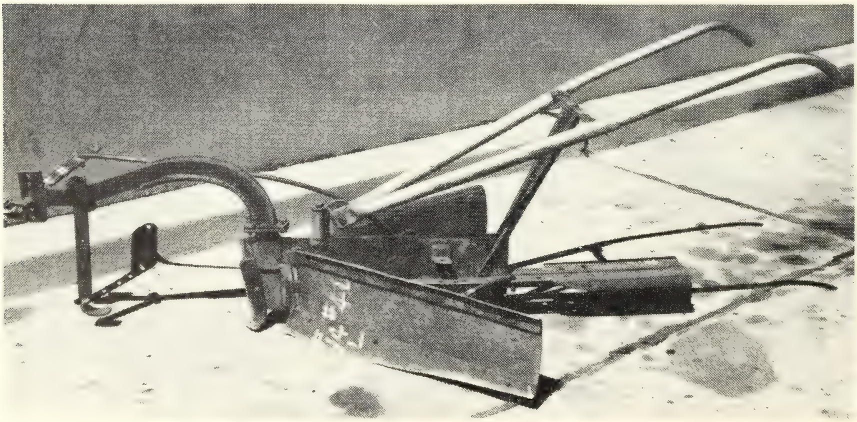
John W. Farker

Forester, Region 4, U. S. Forest Service

In our development of fire line equipment we have to keep in mind that a large part of the West does not lend itself to the use of conventional type of mechanized equipment such as tractors and tankers. The country is too steep and rough. The shovel and Pulaski are still the tools that build much of the fire line in too many cases. The hope of every fireman is that some successful gadget will be made that will do most of the job mechanically. Until that machine arrives we must make good use of the work horse and plow.

Merle G. Markle, fire control staff man on the Challis Forest, developed a **V**-type plow for fire lines that has possibilities. The plow will do the work if it is gotten out on the fire line with a good work horse and a trained crew. The Challis plow has developed into a good trail plow as well. Those who have used it on trail maintenance claim that it is superior to any of the other trail graders commonly used.

The Challis plow has a number of characteristics that are advantageous. A land slide prevents the plow from swinging from side to side. The handles are adjustable for individual preference and for securing better control while working on steep slopes. Wings of the **V** may bet set at any angle and either one or both may be used. Either wing can be raised out of the way for steep sidehill work, allowing the lower or cutting wing to function at its best. The point of the **V** is removable and different points are used according to the work being done.



The Challis plow showing details of construction.

The depth which the plow digs can be adjusted by different settings of the coulter and the heighth of beam. By an adjustable clevis and pull bar the draft horse can be so applied that the plow travels in a straight line and does not tend to run to one side.

Some of the advantages of this plow over the reversible hillside plow commonly used are that it makes a wider line and digs only deep enough to remove the fuels down to mineral soil. The point of the **V** is so shaped that it will not get hung up on roots and rocks. This was particularly bad with the conventional plow, causing terrific strain on the plow shaker as well as the horse.

The plow weighs about 130 pounds. This weight cannot be reduced very much and still get the performance through rough going. The plow needs the weight and it needs to be rugged. It can be disassembled for packing on a horse in a few minutes.

The cost of the plow if made by hand will be approximately $200. If it is made in quantity, this price could be materially reduced.

LITTLE TRACTORS IN FIRE FIGHTING

JOHN W. PARKER

Forester, Region 4, U. S. Forest Service

We have large areas in Region 4, as have other regions, where tractors can construct fire lines with greater speed and less cost than can men with hand tools. We know that large tractors of the D–7 or D–8 class once they are on the job can do more work and cover steeper terrain than any small tractor yet designed, but these big machines are slow to get there. Large transports with 20-ton loads move slowly over any mountain road. Short turns and weak bridges further delay them. However, for the big fires where several miles of line may be necessary the big machines are good business even though it takes them longer to arrive.

The problem is to get the small initial attack crew there soon enough with adequate equipment to control the fire before the big outfits are needed. The little H. G. Oliver tractor, Model HGP–42, built by the Oliver Corp. of Cleveland, Ohio, is a tool that promises to do much in strengthening these fast hitting crews. Some of its specifications follow:

Weight	3,600 pounds.
Width of tread	50 inches.
Length of tracks	6½ feet.
Width of dozer blade	6 feet.
Width of track shoes	9 inches.

In actual tests the tractor operated satisfactorily around a side slope of 40 percent without building a road to travel on. It appears stable and has little tendency to tip over. It would slide before tipping in most situations. The tractor tends to stand on its nose when backing up a steep slope, a characteristic of most little tractors. However, it moved up the 40-percent slope in reverse. Rocks and small poles hinder its climbing in reverse considerably.

The H. G. tractor can work down 60-percent slopes where rocks are not too much of an obstacle. Steeper slopes can be descended by a skillful operator if the ground is reasonably smooth. The tractor will climb slopes of 50 percent or more depending on the ground condition. The testing of the forward climbing ability of the tractor was limited because it has no fuel pump, a situation that can and must be remedied.

The tractor was operated through heavy brush including cherry, ceanothus, and willow, over terrain averaging about 10-percent slope. An adequate fire line was built at the rate of one-fourth of a mile per hour. It was the unanimous opinion that 25 men could not have done as well in the same length of time. The tractor also bucked a fire line up through similar brush on a 25-percent slope with comparative ease. By busting out a rough line up the slope and completing it on the return trip the line on the 25-percent slope was done at about the same

The H. G. tractor: *Left*, worked through this brush patch up a 10-percent slope with ease; *right*, built this 6-foot road through heavy brush on a 50-percent slope.

rate as that on the 10-percent slope. In open penderosa pine type on moderate slopes the H. G. tractor can build fire lines rapidly. As shown in the picture, a short piece of 6-foot wide trail was built across a 50-percent slope with ease. Where there is need the tractor can build itself a road.

The Beetle trail tractor lacks the power to do the fire job in any except the most ideal situations. The mobility of the Beetle is not appreciably greater than the H. G. tractor. A $1\frac{1}{2}$-ton truck can transport the H. G. tractor easily.

There are a few bugs in the H. G. that should be corrected. It needs a fuel pump as mentioned before. There is no brake except that used in connection with the steering clutches. This is dangerous in steep country and could be remedied by having a foot brake operated by the right foot. The tractor has more power than traction and it is believed that if the tracks were 2 inches wider traction could be increased.

The premise is that if we can get a small force to any fire quickly enough after the fire starts they can control it promptly. This is a true statement for 99 percent of our fires and the force usually needs to be only a man with a shovel or water bucket. Since we cannot reach every fire in time for one man to extinguish it with these simple tools, we must provide better tools and in some cases more men. We have been quick to supply the increased number of men but slow to acquire better tools.

A 5- to 10-man crew used for initial attack equipped with back pumps, shovels, Pulaskies, a 100-gallon pumper unit mounted on a 4-wheel-drive vehicle and a H. G. tractor transported on a 1½-ton truck could be a potent force. The training of this crew, if it is to function properly, would prepare them to use the most suitable tool or tools to fight the fire at hand. There should be no hesitancy on their part to all grab shovels and go to work when the need arises. Briefly, they would not be essentially a tractor crew, but the tractor would be one of their tools to be used where it would best do the job.

Channel Iron Bed for Plow Carrier Truck.—The beds of our conventional Hi-Low semi-trailer, used in transporting tractor-plow units are usually constructed of 2- by 8-inch rough oak plank. The plank is bolted to the trailer channel sills to form the ramp and runway for the tractor-plow unit.

On a fire forest it becomes necessary to load and unload the unit many times during a season. The grousers on the tracks of the tractors soon wear out the wood flooring. In order to keep the bed of the trailer safe for transporting the tractor unit, it was necessary to constantly replace the 2- by 8-inch planks. This frequent replacement of the planking soon became quite an item of expense because of the high cost of good grade oak lumber.

Before the spring fire season started, the Ocala unit of the Florida National Forests, installed a channel iron bed on one of their carrier trucks. The channel iron used was 8 by 2 inches, bolted to the trailer channel sills with ½-inch bolts, with the cleat side up to form the floor of the trailer. Two bolts were used on each end of each channel floor piece.

To floor the 21- by 7-foot trailer bed, required 5 pieces of iron 7 feet long and 18 pieces 2½ feet long. The channel iron on the incline or ramp part of the trailer bed was spaced 8 inches apart. On the flat portion of the trailer, the 2½-foot sections of channel were used, spaced 8 inches apart but with a 2- by 8-inch plank left between each piece of iron. By placing the channel iron on the truck bed with the cleats up, good traction was obtained for the tractor tracks for loading and unloading. By having 2- by 8-inch wood pieces between each channel on the flat section of the trailer bed, the tendency of the tractor to slide from side to side while the truck is in motion was eliminated.

This change over from an all-wood to a steel-wood combination trailer bed has eliminated renewing the all-wood bed at frequent intervals and we believe will result in a more practical and safe trailer to use in transporting fire suppression tractor-plow units.

The channel iron used in making the bed cost $87 and labor to install the pieces on the trailer amounted to $10. During the past 5 months no replacement of the remaining wooden boards has been necessary. The steel channels take up the shock of the grousers and the wood serves as a cushion and stabilizer.—JACK THURMOND, *District Ranger, Ocala National Forest.*

PORTABLE FIELD TELEPHONE

Francis W. Woods

Communications Engineer, Region 4, U. S. Forest Service

Region 4 has attempted to help the field man in his communication problems by assembling a metal-covered field telephone that will stand all the transportation abuses common to items hauled in pickups and carried on pack mules.

The development was not a complicated process but does give us a telephone we think the men can use. The telephone instrument itself is the Army EE–8–B field telephone complete with receiver, transmitter, ringer, and call bell. The performance of this instrument is equal to any of the better Forest Service telephones. The old

leather case that came on the Army EE–8–B phone did not protect it sufficiently for the hard use our field men gave it. To overcome this a durable case 5½ by 3½ by 9½ inches was made to house this telephone. Instrument and case together weigh 11¾ pounds. Field tests indicate that the unit is quite satisfactory both from the operation standpoint and from its ability to withstand hard use. The cost of this complete unit is about $50 if a new telephone unit is purchased. The Army EE–8–B field phone can be purchased as surplus for various prices. The cost of the durable case is about $10 when built by hand.

HOSE WASHER

H. M. White

Division of Fire Control, Region 6, U. S. Forest Service

Every year it is necessary to wash a considerable footage of fire hose, mostly cotton-jacketed rubber-lined, at the regional warehouse in Portland, Oreg. In bad years, the amount may be 50,000 or 60,000 feet. For many years, methods of washing without scrubbing have been employed, to avoid wear on the jacket.

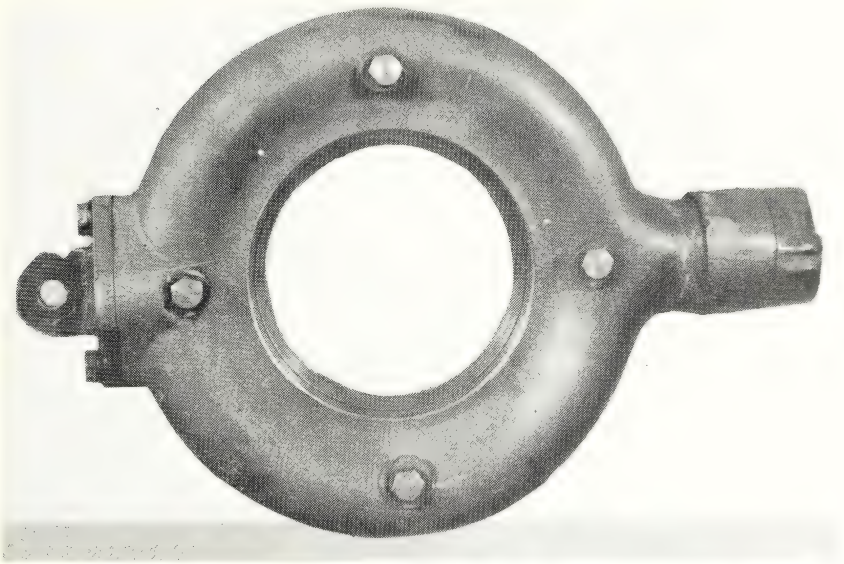
In the first really effective washer constructed, two short pieces of 1½-inch brass pipe, each having a narrow slot about 3 inches long, were installed several inches apart, so that as the hose was drawn between them, ribbon streams under fairly high pressure were directed at the hose from above and below. A good job of washing was done by this method, except at the edges of the flattened hose.

The installation of two additional sections of slotted pipe at right angles to the first two was being considered when Roy Walker, veteran warehouseman in charge of the fire cache, had a better idea. He designed what he called a "doughnut" casting, having a slot all around the hole.

The casting is made of valve bronze and an ordinary 1½-inch swivel hose coupling is brazed to the intake. The outside diameter is 9½ inches and the inside diameter 4¾ inches. The slot is cut at an angle of 30° to the plane center line, to increase the effectiveness of the stream. Width of the slot can be varied, up to 0.020 inch, by adjusting the four bolts shown. These bolts serve a dual purpose: Slot adjustment and strengthening the casting. We set the slot at 0.006 inch and use 200 pounds pressure.

The box in which the casting is installed can be constructed in various ways, of course. We use a box, 34 by 15 by 12 inches, made of ¾-inch waterproof plywood. The bottom consists of two pieces, sloped toward an opening at the center to let the water out. The ends have holes through which the hose is drawn and the casting is installed across the center, with the slot facing the entrance.

To support the hose as it is drawn through the box and casting, we use two assemblies of 16¼-inch rods about 15 inches long, set in a circle somewhat smaller than the inner diameter of the casting. These rods do not extend through the casting, as they would interfere with the stream. Their ends are set in brackets, attached to the four bolts. The forward assembly is about ¾-inch above the slot at the bottom so that the hose will not rest on the casting. The rear assembly is lower, so that the hose couplings will not catch on it.



"Doughnut" hose washer in same position as installed in box.

Preparatory to washing, coils of hose are soaked in a large tank for several hours to soften caked dirt. Then the hose is drawn through the washer and out onto the test and drying rack as fast as a man can walk. It comes out thoroughly cleaned of everything that plain water will remove. Water is supplied from an electrically driven gear pump.

Since the patterns for the casting are owned by the Forest Service, anyone desiring to purchase one may order from the Supply Officer, 2760 Northwest Yeon Avenue, Portland, Oreg. The one we have costs $5.75, exclusive of patterns and machining. The price would probably be somewhat higher now. The machining costs much more than the rough casting, of course. It could be done locally from a drawing to be supplied, or the Portland supply officer could have it done, if the purchaser desired.

PROPANE-DIESEL OIL FLAME THROWER

A. B. Everts

Fire Staffman, Snoqualmie National Forest

The October 1946 issue of Fire Control Notes described a flame thrower developed by the Los Angeles County Department of Forester and Fire Warden in which butane was combined with Diesel oil to produce an exceedingly hot flame for heavy backfiring jobs. In the Los Angeles unit, a compressor was used to pressurize the Diesel oil and, of course, an engine was necessary to run the compressor.

A somewhat comparable unit has been developed on the Snoqualmie National Forest which utilizes the gas pressure in such manner that an engine and a compressor are unnecessary. This is done by using propane instead of butane. The reason propane will perform the pressurizing function while butane will not is the difference in pressures at given temperatures as shown in the following tabulation:

	Pounds pressure	
Tank temperature (degrees):	*Propane*	*Butane*
40	63	[illegible]
60	92	1[illegible]
80	128	2[illegible]
100	172	3[illegible]

B. t. u.'s per pound of liquid are: Propane 21.633; butane 21,33[illegible] Propane will start to vaporize at −44° F., while butane needs a tem perature of 32°.

The Snoqualmie unit, also trailer mounted, is made up of tw standard ICC, 600-pound test, 48-gallon propane tanks, to whic have been added the necessary fittings, a hose basket, three 25-fo lengths of one-half inch Buna S-lined neoprene hose, and torch (fi 1). The hose basket is welded to the tanks and provided with lif so that the whole unit can be removed from the trailer with a cha block.

The gas tank, not visible in figure 1, has a 10-percent valve, a t outlet valve, and a pressure relief valve, which is set at 300 poun The oil tank (shown) is identical except that it has a 1½-inch t filler vent for Diesel oil, a copper tube which runs to the bott of the tank to release condensed moisture, a Davies type press release valve, and a pressure gage. Oil is released through the va in the center of the head. A down curving tube runs through center of the oil tank to within 1 inch of the bottom.

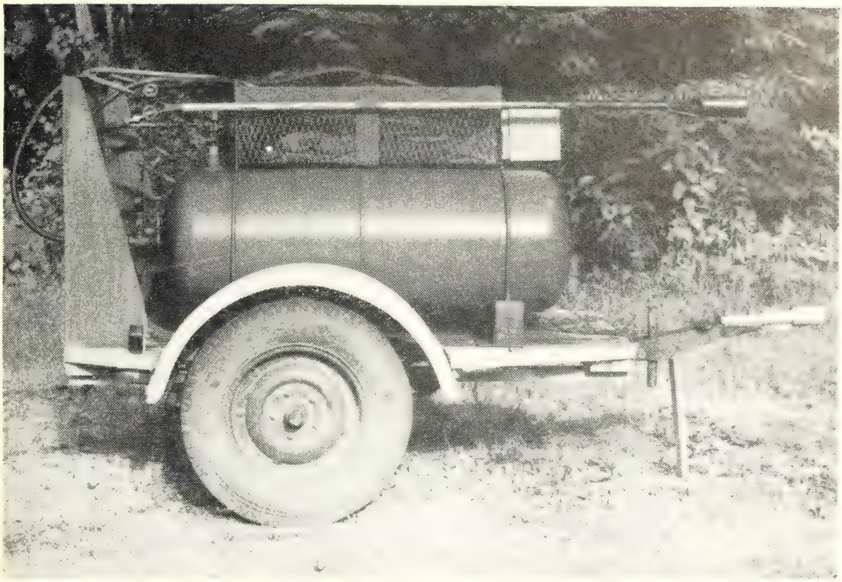


FIGURE 1.—Trailer type propane-Diesel oil flame thrower. The wooden end piece at rear is for protection of valves.

A copper tube runs from the gas tank to the oil tank to permit the propane to pressurize the oil, usually from 75 to 125 pounds. When the oil tank is empty, pressure is relieved through the Davies type valve and the tank is refilled. This valve is a standard safety installation for this type of equipment. If the escaping gas should be ignited, the screen on the valve would prevent the flame from getting into the tank.

To fill the gas tank, a standard propane tank is up ended and elevated so that the liquid gas will flow through a special hose. The 10-percent valve is opened slightly to allow the air or gas to escape. When the incoming liquid gas reaches the 10-percent valve, a mist is released, indicating that the tank is filled to the safe working level.

The torch is 6 feet long. It is made of 1-inch stainless steel tubing, with a naval bronze mixing cap at one end and two valves at the other, one for gas and one for oil. In hard-to-ignite fuels, such as old logging landings, the gas discharge may be reduced and an excess of gassified oil applied to the fuel, after which the gas is turned on full again to produce a flame as shown in figure 2.

The reason for breaking up the hose supply in 25-foot lengths is the high friction loss in small hose. The pressure obtainable from the propane tank is sufficient for a reasonably long flame throw with 75 feet of hose, but where that much is not needed, it is desirable to use a shorter length and thus increase the flame throw.

Freezing, which frequently occurs in any liquid as it converts to gas, has not been a problem with this unit. The reason is that the

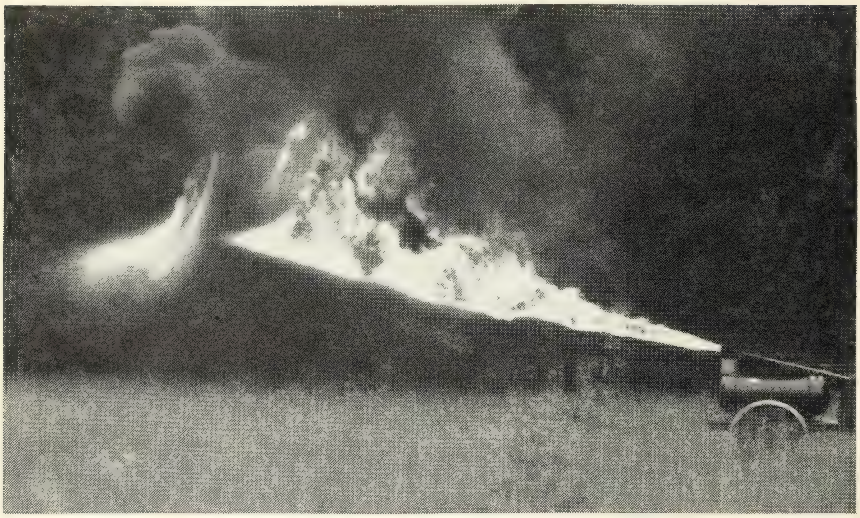


FIGURE 2.—Propane-Diesel oil torch with oil and gas turned on full.

freezing is in direct relation to the surface area of the liquid, and with the tank lying on its side the surface area is sufficient to prevent freezing.

Two of the trailer units were purchased for ranger use. They were so well received that a third ranger, with a large amount of slash to burn, also wanted one. By this time an improvement had been added. Why should the propane tank be filled when tanks provided by the oil companies can be used just as well? In this case, when a gas tank was empty, it could be replaced with a full one. There was only one problem: with a full tank lying on its side, liquid would be drawn off instead of gas. This was solved by installing a vaporizing cylinder 6 feet long and 6 inches in diameter. The gas enters the vaporizing cylinder on the bottom as a liquid. It is withdrawn at the top as gas to pressurize the oil tank and to furnish gas to the torch.

At this writing the three units described have been used to fire sage brush in a range reseeding project, burn out a slab and sawdust pi at a small mill, fire log landings, set slash fires, and burn piled brus It has been suggested that it might be a formidable weapon to fig the invasion of Mormon crickets which occur periodically in some the Western States.

From experience gained so far we believe one filling of propa on the trailer unit will last through 4 or 5 days of judicious burni About one tank of oil is required daily.

Pressurizing oil with propane gas is the idea of a Seattle manuf turer, who has applied for patent on the idea as well as on the d control torch which is used with the unit.

Since a heavy unit, as described, is limited to roads and tractor trails, there is need for a companion unit for use on rougher and steeper terrain. Such a unit is shown in figure 3. In theory, it operates in the same manner as the propane torch shown in the Fire Control Equipment Handbook. Its advantage over the old type is that, while it carries nearly twice as much propane, it weighs only 45 pounds as compared with the 47 pounds of the old type. The tanks are shatterproof stainless steel oxygen tanks tested to 600 pounds and provided with a safety release set at 175 pounds. The tanks are mounted on a plywood packboard which gives protection from freezing not provided in the clack board mounted older type. The torch is light and has a thumb controlled valve. A 10-percent valve is provided for safety in filling.

FIGURE 3.—Improved back-pack propane torch.

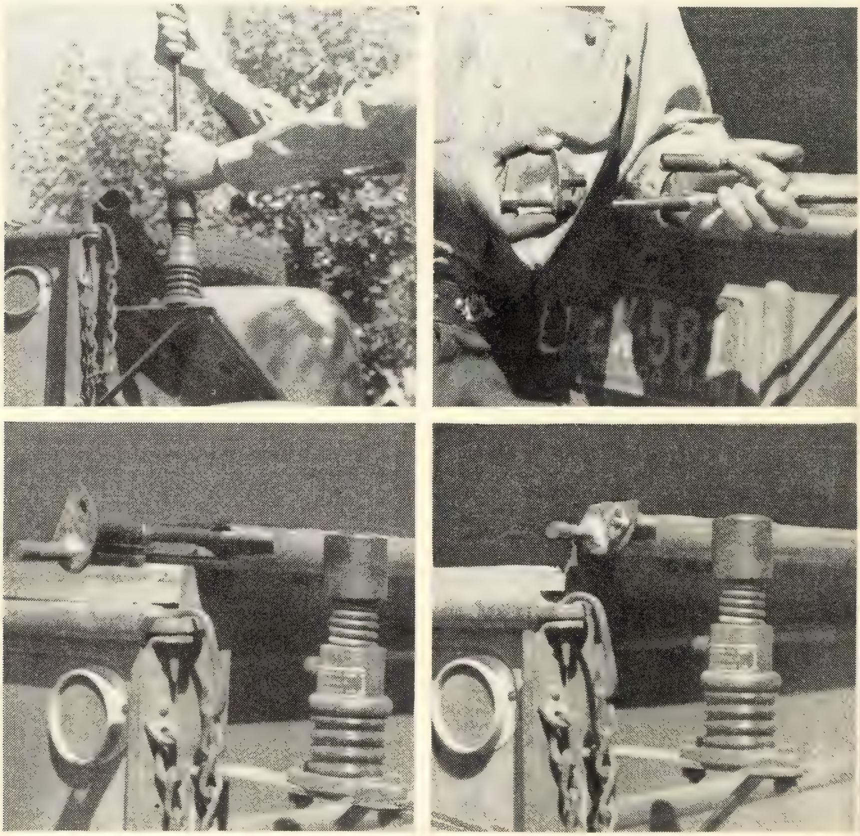
In a later version of this torch, one tank is used for Diesel oil which, as in the trailer unit, is pressurized with the gas. This unit has two hose lines. It can be used with both tanks filled with propane or with one tank of gas and one of oil.

CARRYING A TWO-SECTION WHIP ANTENNA FOR PORTABLE RADIO

Don M. Drummond

Assistant State Fire Warden, Nevada

Elko County is one of the largest counties in Nevada. It is bigger than the combined area of the three smallest States in the Union. In this sparsely settled country, single fires have been known to burn thousands of acres of range forage. Ranches, including the hay



Steps necessary to put the antenna away for carrying: *A*, Dismount antenna from base mounting spring and loading coil; *B*, fasten carrying cap to two sections of antenna; *C*, slip antenna into "carrying case"—rolled edge of pickup bed; *D*, fasten cap with wing nut, stored antenna is in travel position.

stacked for winter, miles of fences, ranch buildings and homes, have at different times gone up in smoke. Communication is a vital problem in fire control work on such a large area with so few people.

Through Government surplus the Nevada State Board of Fire Control and the Nevada Extension Service secured several portable radios—Fisher type RS253 and TW253. Elko County is experimenting with them. The county fire warden has learned that the vertical two-section whip antenna is too heavy and tall to be left mounted during all his miles of travel. The radio sets are portable—not mobile—requiring that he stop his vehicle before using the radio. He must carry the antenna where it is well protected, and also in a position where it is easily and quickly available. He slips the two sections of the antenna into the rolled edge of the pickup bed and holds the ends of the antenna firm with a special cap he has fashioned. A wing nut holds the cap and antenna "in storage." The antenna can be unpacked and set up in a matter of moments.

BACK-PACK PUMP CARRIER

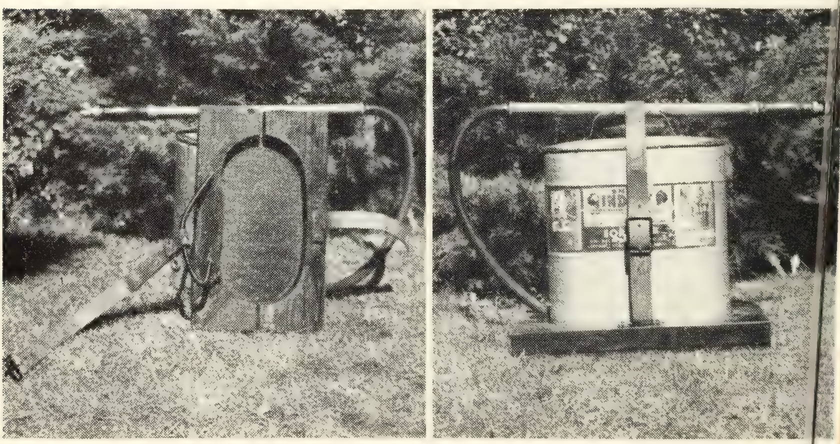
JOHN W. PARKER

Forester, Region 4, U. S. Forest Service

The back-pack pump can has become a standard piece of fire fighting equipment in several sections of the country. These cans are carried in trucks, pickups, tankers, and other vehicles. The problem is to have a carrier that will hold these in place so they will not get damaged or spill the water when being hauled. The safety of the men who ride in the vehicle is also involved. Quite frequently a pump can must be carried in an administrative pickup being used for other work and it is necessary that it be placed on the running board or other convenient place where it will not be in the way. There are several pump carriers on the market but they are expensive and usually will accommodate only one make of pump can.

The Wasatch Forest developed a back-pack pump carrier that can be constructed cheaply and can be made to fit any shape pump can. The Wasatch pump carrier requires the following materials with their estimated costs:

2 pieces 2- by 6-inch lumber	$0. 2
1 piece leather strap 1½ by 36 inches with buckle and keeper	1. 5
1 screen door spring, extra heavy type	. 1
1 piece 5-ply plywood for bottom	. 2
Total material cost	2.
Labor to assemble	1.
Total cost	3.



Left, top view of pump can carrier. *Right,* pump can mounted in carrier.

The screen door spring is attached to the bottom in the form of a loop. The leather strap is fastened to the loop. With this arrangement the strap when buckled is under constant tension from the spring, thus holding the can firmly in the base.

Two bolts will hold this carrier securely to a truck bed or a running board. Two brackets will hold it on the side of a vehicle if there is no space available on running board or truck bed. A detailed plan for the back-pack pump carrier may be obtained from the U. S. Forest Service, Ogden, Utah.

Ruidoso.—Ruidoso, N. Mex., has been something of a fire problem to the Lincoln National Forest, which surrounds it, for a number of years. The town is situated along the Ruidoso River on a stringer of patented land 4 miles long and ranging in width from ¼ mile to 1½ miles in the heart of the ponderosa pine type. This 4-mile strip of private land is traversed by the main road or main street, with only one outlet to the north over a secondary road at about the midpoint.

Prior to 1920 Ruidoso was just another small, mountain country community. The local people were dependent on farming and ranching. One or two small sawmills operated on a part-time basis and contributed very little to the local economy.

By 1925 Ruidoso had grown. There were a number of summer cabins constructed along the river and people were spending the summer months there. It was considered advisable for the District Ranger to maintain a summer camp in Ruidoso to take care of the fire problem. At this time, "everyone" except the postmaster left Ruidoso in September, came back in November to hunt, then stayed out until the following May or June.

Ruidoso continued to grow; and so did the fire problem. To get some idea of the magnitude of this problem, one must consider that Ruidoso grew within a short time from a summer home group into a thriving summer resort with crowds estimated at 12 to 15 thousand for week ends and 18 to 20 thousand for the Fourth of July celebrations. The fire problem remained the responsibility of the Forest Service. Key individuals in Ruidoso gave excellent but limited cooperation.

In the early development of the Ruidoso area the Forest Service realized the responsibility of local fire protection belonged to the town of Ruidoso. However, the situation was such that it was necessary to protect Ruidoso in order to protect the forest. At times the outlook was very discouraging. Lack of fire-fighting equipment was a handicap to both the Forest Service and the town. Rakes, shovels, and back-pumps were standard equipment up to 1939. In 1939 an Edwards pumper and 1,000 feet of hose was purchased for the Ruidoso area; in 1945 a tanker truck was added. In 1948 a new up-to-date fire engine was purchased by the town.

At the spring fire meeting this year the Ruidoso fire department took over the responsibility for suppressing all fires in the Ruidoso area, the Forest Service to assist when called upon. The Forest Service was to handle all fires outside the area, the Ruidoso fire department to assist when needed.

To me two points in handling this problem are outstanding; the number of man-caused fires and property loss have been held to a minimum, and the working relations between the town of Ruidoso and the Forest Service have been very good at all times.—Lee Beall, *Range Conservationist, Lincoln National Forest.*

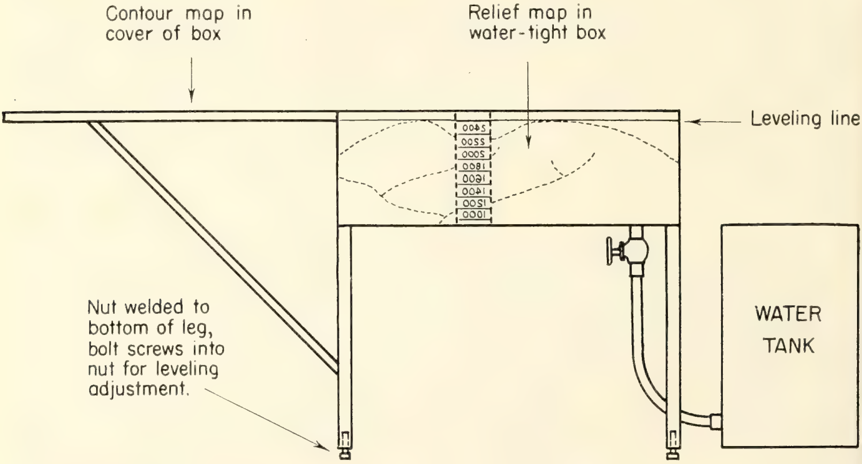
DEVICE FOR TEACHING CONTOUR MAP READING

Ralph G. Brown

District Ranger, Stanislaus National Forest

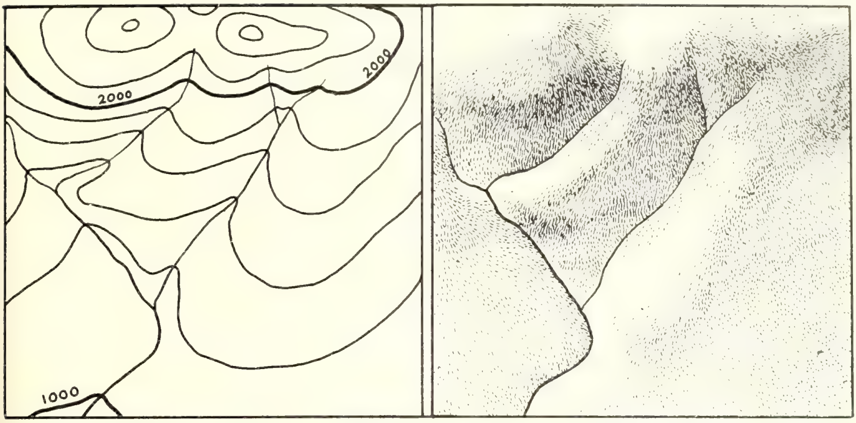
Device consists of:

1. Water tight box with legs adjustable for leveling.
2. Relief map built up inside of box showing peaks, saddles, ridges, creeks, various slopes, benches, etc.
3. Line marked inside of box, near top, to use as leveling guide with water.
4. Vertical scale mounted inside of box, graduations coinciding with contour interval.
5. Drain installed through bottom of box.
6. Water container capacity equivalent to map box, connected by rubber hose and shut-off valve to drain.
7. Contour map mounted in lid of box, depicting the topography of the relief map and on the same scale. Contours numbered to correspond with those on the vertical scale in map box.



How used:

1. Map box set up and leveled.
2. Shut-off valve opened and water tank raised above level of box allowing relief map to be flooded. If dye or other coloring matter is added to the water to make it opaque it is more effective.



CONTOUR MAP RELIEF MAP

3. Valve shut off and tank returned to position below box.

4. Valve cracked to bring water level down to number on scale representing highest contour on contour map. *Water line on relief map corresponds and represents contour line on contour map in lid of box.*

5. Crack valve and lower water to next graduation on vertical scale. Repeat process for each contour with explanation.

SPIRAL ROTOR TRENCHER

T. P. Flynn

Equipment Engineer, Region 6, U. S. Forest Service

The spiral rotor trencher is a light-weight, motor-driven machine being developed for fire-line construction. A revised pilot model was completed and given preliminary field tests 3 times in June and July 1948. The most recent test was conducted at high elevation in the Cascade Range on the Mount Hood National Forest.

The most noteworthy mechanical feature of the machine is the 2-way tapered, spiral rotor digger or trencher tool, a positive excavator type rotating between 250 and 300 revolutions per minute.

Trencher showing arrangement of the spiral rotors.

Power is supplied by a 6-horsepower, 4-cycle Salisbury motor. The spiral excavator uses about 70 percent of the power and the traction wheels about 30 percent. Power steering to the tractor wheels is incorporated and appears well worth while in that it greatly reduces fatigue of the operator. Positive chain drive propels the spiral rotor and delivers the primary power to the rear wheels.

An important improvement in the latest revision of this machine is an automatic slip clutch installed in the power drive line to the spiral rotor. This slip clutch goes into action when excessive overloads are caused by collision of the rotor with immovable objects. It dissipates a large amount of shock that otherwise would reach the motor and main transmission. This feature is well worth the additional cost involved because it serves as insurance against breakage of valuable parts in the transmission.

Traction wheels are 24 inches in diameter and 24 inches apart (center to center). The axle is 12 inches from the ground with the transmission partly underslung. The complete unit, which weighs 500 pounds in its present form, has a low center of gravity and good stability for rough country operations. Its travel speed is 1 to 1.3 miles per hour.

Ground conditions for the tests made on the Mount Hood generally would be considered difficult for almost any size of machine, because of very frequent and heavy lava rock outcrops. Specifically, the average ground condition in which the trencher was used classified as about 75 percent red clay soil and 25 percent small boulders from 4 to 8 inches in diameter. Cover consisted of a heavy stand of pine timber with a heavy undergrowth of small manzanita brush; quite a few down logs and broken limbs were present on the surface. There was usually sufficient space to maneuver the trencher around the large logs and between the heavy patches of manzanita brush as well as between the rock outcroppings.

To determine the limitations of the spiral rotor trencher, its durability, output, and quality of trench under rough conditions, and its ability and effectiveness in general, trenches were made up steep grades, on sidehill, downhill, and on the outer fringes of heavy rock outcrops.

Stop-watch checks showed that in reasonable ground conditions, at least 20 percent rocks and boulders in this case, excavating speed was approximately 1.1 miles per hour. This speed allows the operator just about the right amount of time to pick his course. Trench width averaged about 22 inches of actual excavation and the berm of cast out materials on each side averaged about 7 inches. Although the depth of trench could be controlled easily by the operator's handle, an average depth of 4 to 5 inches was used as a standard, principally because this depth permitted the outer ends of the spirals to clean up the outer edges of the trench and leave a neat line without any fall-back.

The tendency of the rotor is to dig or excavate at all times without any excess force applied from the operator's handle. It does not lead into the ground fast or suddenly, and when it encounters immovable objects, such as large boulders or roots, the rotor automatically climbs and slides over them.

The spiral tool excavates and pushes dirt both ways from the center. Its taper in diameter from the center outward accomplishes two things: Reduces excavating load pressure on the outer ends of the tool, and

Trencher in action. Note splash and the clean trench constructed.

tapers the bed of the trench upward toward both edges. The excavated materials deposited at the edges of the trench remain very firm so that fall-back is practically negligible.

The spiral splashes dirt about 2 feet from its outer ends. Although it was not intended that this pattern of spiral was to throw dirt very far, the small splash would be beneficial when working close to a fire line.

One interesting discovery about the behavior of a spiral rotor working at right angles to the line of travel, made during earlier experiments, was that better results are obtained when the spiral rotates in the opposite direction from the tractor wheels than when it rotates in the same direction. Rotating the spiral in the same direction as the wheels, instead of providing some forward traction as well as excavating, resulted in a tendency to climb out on top of the ground and otherwise leave ragged edges to the trench. Rotation was reversed and the spiral now does its excavating on the upturn, coming from underneat against the cut. The spiral rotation now used leaves a neatly excavated and highly satisfactory fire trench.

At this stage there appear to be only a few adjustments, such a reducing the travel speed some to favor the operator when excavatir in difficult ground, and simplifying and streamlining the power tran mission to the tractor wheels. The spiral trencher tool is the outstan ing feature of the machine and its shape and relatively low rotati speed reduce the possibility of damage or breakage to a minimu The 6-horsepower motor used is adequate. The proportion and ba ance of the machine appear to be quite satisfactory.

DRIVEN WELLS FOR FIRE SUPPRESSION

EDWARD RITTER

Region 7, U. S. Forest Service

An old story need not be often repeated unless it serves a particular purpose. There is little new in this story as it describes the use of water on forest fires. But because it deals with a specified locality and individual fires, it is thought the information may be of interest to others. The area is Cape Cod, Mass.

Growing up as a westerner and working on forest fires in the dry ponderosa pine type of the Inland Empire has tended to make me water conscious if only from a standpoint of having sufficient drinking water on the fire line. In 1930 while reading accounts in the Idaho Statesman of the serious forest fires in the East little did I think that some day I would be back there and find out first-hand what some of their problems were. Cape Cod, instead of being the mass of sand dunes I had expected, turned out to be a relatively rugged area of forest land, much of which is strewn with massive boulders and rock formations. The use of driven wells did not look very practical at first but the district fire warden, Massachusetts Department of Conservation, had progressive ideas and wanted to prove to his satisfaction that driven wells could be used to advantage on forest fires.

Use of water from driven wells for forest fire suppression is not unique although it is believed that the following instances, described by E. Ormand Dottridge, district fire warden for the Cape Cod area with headquarters at Cotuit, Mass., may serve as reminders of what might be accomplished elsewhere under certain conditions.

The Horse Pond fire which occurred at 3:40 p. m. on August 24, 1947, on a class 3 day was controlled before mignight of August 24, mopped up and declared out at 4 p. m. August 25. Although the fire was only about 5 acres in extent, 1,100 feet of line was bulldozed between two ponds to aid in corral, and the remainder of control and mop-up was completed entirely with the use of water. Fourteen thousand and three hundred gallons of water were applied through use of 5 fire trucks and 83,140 measured gallons were applied by 2 portable power pumps using the ponds as a source of water although driven wells would have served satisfactorily. Only 2 hose lines were used, each about 500 feet in length.

On August 6, 1947, at 11:15 a. m., a fire started near South Mashpee. It was a class 3 day, but only 1½ acres burned. The fire was knocked down by use of a county brush breaker and a town fire truck. A portable power pump was attached to a hand-driven 2-inch well pipe with a common button point and a 60-mesh screen. The well was placed in about the center of the burn and 200 feet of 1½-inch rubber-lined hose was sufficient to accomplish the complete mop-up job. A one-quarter-inch nozzle tip was used and an average of 12 gallons per minute was pumped. Between 4:30 and 9:30 p. m., August 6, 3,600 gallons were played on the burn and 4,320 gallons between 8:30 a. m.

Portable pumper at work on South Mashpee Fire, Cape Cod, Mass., August 1947.

and 3:30 p. m. of August 7. Seven tank trucks were used to apply 9,080 gallons of water on the burn during the 2 days, making a total of 17,000 gallons.

District Fire Warden Dottridge stated it took 20 minutes from the time the equipment arrived on the scene until water was being pumped on each of these two fires. He has loaded on a half-ton pickup truck a set of equipment which includes 2,400 feet of 1½-inch linen hose, 400 feet of 1⅛-inch rubber-lined cotton-jacket hose, two portable pumpers, suction hose, Siamese fittings, adapters and nozzles, two back-pack pump cans, two 5-gallon cans of gasoline, one 2-gallon gasoline can, a small complement of hand tools and the well equipment.

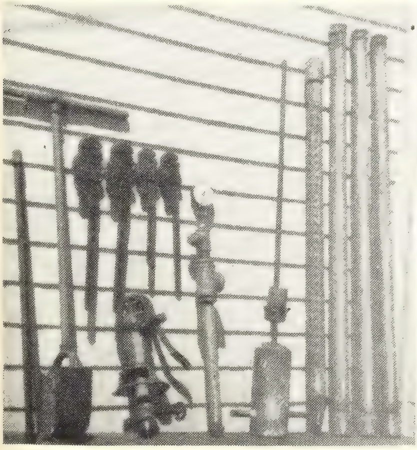
Driving a well point is not so mysterious as it is laborious. Th[illegible] accompanying photographs illustrate what tools and equipment ar[illegible] necessary and show how they are used. A list of the materials pur- chased by the Massachusetts Department of Conservation is as follows

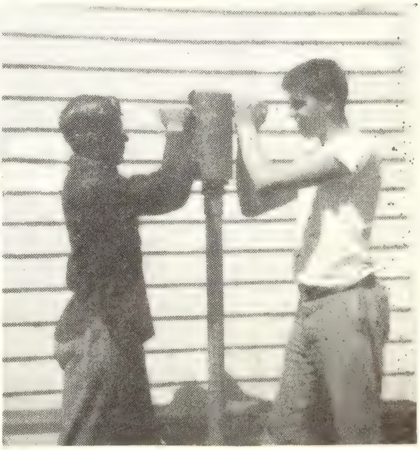
Quantity	*Item*	*Estimated cos[illegible]*
1	2- by 48-inch washer well point	$12.0[illegible]
3	5-foot lengths, 2-inch galvanized threaded pipe	12.9[illegible]
1	2-inch galvanized tee	.8[illegible]
1	2-inch galvanized plug	.2[illegible]
1	2- by 1½-inch galvanized bushing	.2[illegible]
1	2- by 1¼-inch galvanized bushing	.2[illegible]
1	2-inch malleable iron drive cap	.5[illegible]
4	2-inch wrought steel couplings	1.7[illegible]
1	2-arm well driver, 60 pounds	5.[illegible]
1	3-inch pitcher pump	5.1[illegible]
1	3½-inch vacuum gage	9.[illegible]
2	24-inch pipe wrenches	9.[illegible]
2	18-inch pipe wrenches	5.5[illegible]
1	1¼-inch galvanized pipe, threaded on both ends (1½-foot length)	.[illegible]
1	1½-inch smooth bore suction hose, female couplings (4-foot section)	3.[illegible]
	Total	67.[illegible]

Driving the well is simple. First dig out a few scoops of sand or gravel with a round point shovel and post hole digger until the water table is reached. Then place the well point in a vertical position and begin applying muscular action to the 60-pound well driver which can best be operated by two men. When the well point has been driven into the ground sufficiently, make fittings of a 2-inch tee, vacuum gage, pitcher pump, and gate valve. Next, attach suction hose from pump and all is in readiness to start pumping water. When there is no further need for the well, the point may be pulled or it may be capped for future use if desired.

Points which are well to remember if one is interested in trying out driven wells on his district are listed here for consideration.

1. A fair knowledge of the local water table level and wells already driven in the immediate area should be helpful.
2. Study geological survey maps, water levels in adjacent ponds, streams, and swampy areas.
3. Confer with persons using driven wells in the adjacent area at similar levels.
4. Test wells by stand-by crews in areas likely to be used for underground water supply in case of fire.
5. Consult engineers who have made surveys of ground water supplies for municipalities.
6. Ten gallons per minute should be expected from a 2-inch by 4-foot, 60-mesh well point under poor to average conditions and much more under favorable conditions.
7. A series of two or more points may be driven at intervals of 10 or more feet.
8. Any type of pumping equipment may be used.
9. Avoid if possible heavy vacuum on shallow wells. There is danger of rupture of the button screen which would allow sand or gravel to enter the well and possibly ruin a gear pump.





Left, equipment necessary for well driving includes post hole digger, pipe wrenches, pitcher pump, well head assembly with vacuum gage, 60-pound well driver, button type drive point, and three sections of well pipe. *Right*, driving the point is laborious, but two men can complete this operation in a few minutes.

10. After well is driven, use pitcher pump to pump off discolored water into a container. If sand or gravel shows in bottom of container, use caution in operating gear pump. Discolored water may persist indicating for example, swamp water. This will not be harmful so long as there is no evidence of sand or gravel.

11. Take a sample of water from the pump occasionally to determine if button has been ruptured.

12. After pumping for an extended period an increase in vacuum may be noted. This may be due to the draw-down. Vacuum should remain fairly constant with a steady rate of demand by the pump. A constant increase in vacuum might indicate unfavorable soil conditions or rupture of a button screen, and that the well is filling up with sand or gravel. A sudden increase in vacuum would probably indicate rupture of the button screen. These points must be given consideration during all trials and careful observations should be made to avoid damage to equipment so that best results may be attained.

District Fire Warden Dottridge feels that the possibilities of using water from shallow wells may be greater on his district than he had first anticipated. He says, "why lay hundreds or thousands of feet of hose if there is usable water a few feet underground that can be tapped by use of wells?"

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Volume 10 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

SLASH PILING BY MACHINE ON THE SOUTHERN IDAHO FOREST PROTECTIVE DISTRICT

Art Roberts

State Fire Warden, Southern Idaho Fire Protective District

Since the spring of 1945, it has been possible for logging operators on State and private lands in Idaho to contract their slash-disposal job to the State forester at a more or less stable rate on a State-wide basis. The law is written so that any job may be taken on its own merits, but in practice, unless the job is exceptionally difficult, it is taken at the base rate. The actual disposal work is delegated to the State fire warden on the district involved. On the Southern Idaho Forest Protective District there is almost 100-percent cooperation under the law. For this reason, it is possible to consider the problem on a district-wide basis. Roughly, the area is broken into two units and each job is considered with relationship to the large unit. Our use of machines has been pretty well confined to the northern unit which embraces the McCall-New Meadows-Council area.

For the most part the type is yellow pine, and on quite a lot of the area the slope is gentle and the ground open. For this reason, we became interested during 1945 in operating a tractor or two on some of our slash-disposal jobs. Some work had already been done along this line elsewhere and we looked into the results obtained on some of these jobs. Late in 1945 several fire wardens visited the Biles Coleman Lumber Co. operation out of Omak, Wash., in a type very similar to ours, where brush-piling tractors had been in use for two or three seasons. The company was using D–4 caterpillar tractors with 60-inch center and 20-inch track shoe equipped with a specially constructed brush blade manufactured by the Isaacson Machine Works in Seattle, Wash. It was enthusiastic about the results obtained with these machines and was using them on its entire operation.

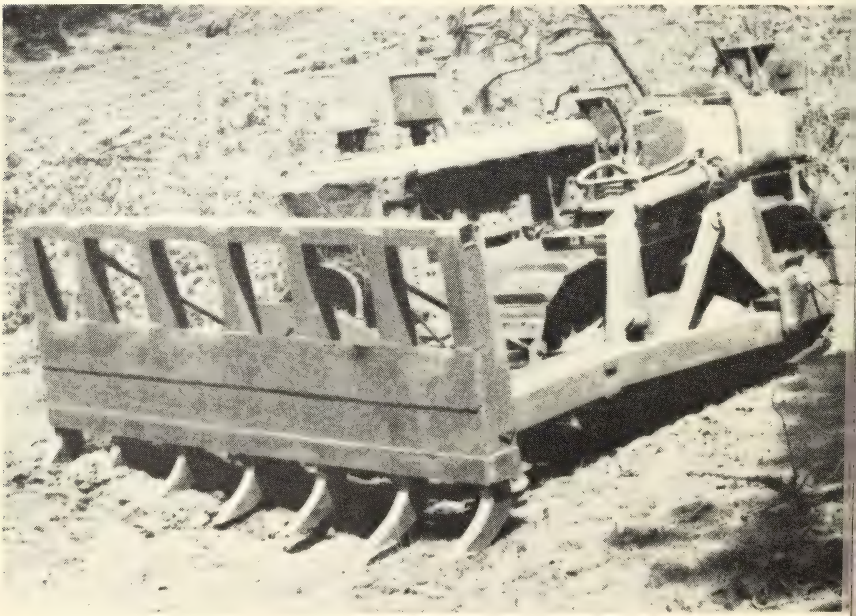
Our efforts to obtain machinery were redoubled and in October 1946 we acquired two D–4 caterpillar tractors through war surplus. These machines were in new condition but were narrow gage (44-inch center and 13-inch track shoe). They were equipped with La Plante-Choat hydraulic angle dozers and double drum LaTourneau winches with fair-leads. Because of the lateness of the season no slash-disposal work was done with these machines until the spring of 1947.

During the early spring, we had special blades manufactured to our specification by the Catlow Transport Co. at Spokane, Wash. These blades were built along the same general lines as the Isaacson blades but with several modifications. In the first place, the blades were made interchangeable with the angle dozer blades already on the machines. This was not the case with the Isaacson blade. Second, we extended the blade 10 inches on each end because of the narrowness of

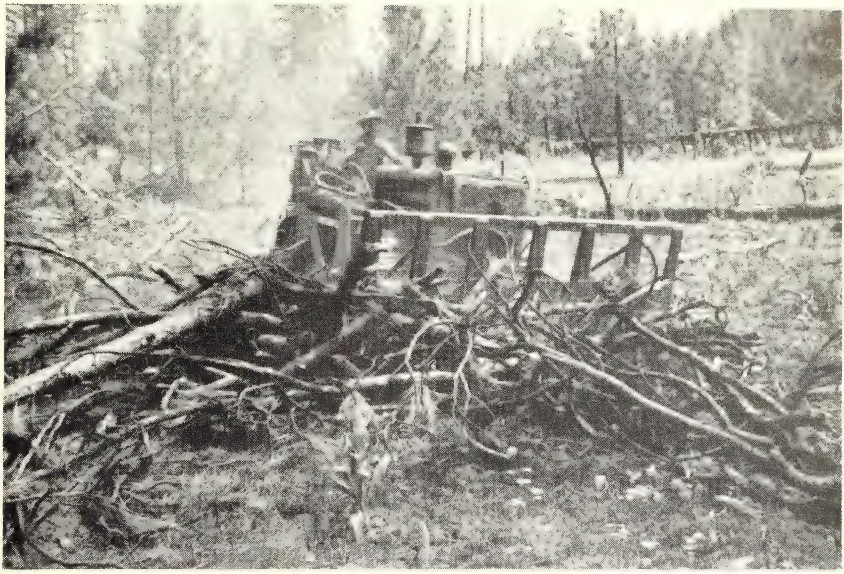
the machine. This made the over-all width of the blade 109 inches instead of the 89 inches of the angle dozer blade. The change made little difference in the hook-up as the dozer arms readily move out an inch from the A-frame and the connections were moved in 9 inches from the ends of the blades. The original arms and A-frame were used. The blade was held in place by the same three pins which held the angle dozer. However, it was impossible to use the brush blade in any but the straight blade position. A secondary brace from the top of the brush blade to the back hole in the A-frame was tried but soon discarded as it was found to be superfluous. Slack in the hook-up also made it very hard to keep this brace from breaking.

The blade was equipped with seven detachable teeth that gave 11 inches vertical clearance and point forward 10 inches from the perpendicular. Above the teeth the blade was solid for 20 inches and was then a lattice-work affair to its over-all height of 50 inches. This open top was left for greater visibility for the operator and to reduce the weight of the blade, which even with this open work weighed approximately 300 pounds more than the angle dozer. One disadvantage of the changeable blade arrangement and the hydraulic dozer is that the blade is some 18 inches in the front of the machine because the A-frame is hung far enough ahead to clear the hydraulic pump. Another is the weakness of the hydraulic hoses in work of this kind. These disadvantages are offset by the speed of change to angle dozer for fire work and the ability of the hydraulic dozer to exert pressure down.

Work was started with one machine in June 1947, and one machine was kept in the field during the entire season or until mid-November. The limitations of the machine soon became apparent. Because of the narrow gage, it was unable to operate on slopes much over 20 percent. Rocky ground also stopped it. No attempt was made to oper-



A D–4 caterpillar tractor equipped with the 7-toothed brush blade.



The D–4 with the brush blade working in heavy slash.

ate in reproduction stands although some tops were winched out of these places. As the season progressed, we worked our hand piling and lopping crews closer to the machine and used the machine only where it worked most efficiently. During 1948 both machines were in the field from June until late October. Our greatest mechanical difficulty was the vulnerability of the oil return hose to the hydraulic pump. This was comparatively safe from brush in front but limbs and small stumps would get it from below and pull it off. Finally guards which extend under the pump and hoses were devised and bolted to the pump and radiator guards. This addition stopped our trouble.

We intend, but have not yet made, a second revision in the original blade. This will be to make the lattice work solid directly in front of the radiator in order to further protect the machine. This will not interfere with the visibility of the operator as he seldom looks directly over the front anyway, but should serve to protect the screen which must be used over the radiator to keep it from fouling up with moss and dust. Experience indicates that the added weight will make little difference, contrary to our original fears.

There are several advantages connected with handling brush with these machines. First, machine-made piles will burn much later than those made by hand because they are larger and tighter. Then, quite a percentage of the windfall and top that would normally be left on the ground gets into the pile. Not all this burns but the flash fuel is no longer around it to give a bad time in the fire season. In operating machines in piling, the ground is worked up, providing a better seedbed. While this is not vital, as it is already pretty well taken care of in present methods of "cat" logging, it still may be an advantage. During 1948 quite a bit of lopping was done with the

machines. This lopping was quite satisfactory where there was insufficient slash to make piles or where the debris was too scattered to make it pay to put it together in piles. Lastly, machine piling is much faster where it is possible and reduces the need for manpower, that has not been readily available during the past few years.

On the Southern Idaho Forest Protective District job, the machines are now used strictly as an integral part of the whole operation and always in connection with men for the outlying areas, the reproduction stands, and the steep or rocky places.

During the bad fire months, July, August, and early September, the machines are kept on jobs as centrally located as possible or as close as possible to our areas of high hazard. The angle dozer blades are kept on the job and the change from one blade to the other can be made by two men in 5 to 10 minutes. The machines are transported on a 6 by 6 International 2½- to 3-ton truck that is kept on the job during the summer months. In the course of the operation the machines are used to keep roads open to the jobs and so give freer access to slash areas at far less cost than that by hand or by hiring it done with contract machinery. As we have had two easy seasons since we started our machine project, we have used them only rarely on fire control but they are always ready and can be moved rapidly.

It is extremely difficult to estimate costs on an operation of this kind, but in areas on which we have done all the work with the machines, our costs for a 100-percent piling job have run from 20 cents to $1 per 1,000 feet board measure depending on the site, the tractor operator, and the quality of the job done. When the machines are used in conjunction with a handlopping operation, the costs, of course, come down. It is our opinion, from 2 years' experience, that a 100-percent piling job can be done, with a good operator and on the type of terrain on which the machines can operate, for about half the cost of a hand job of the same quality.

The D–4 caterpillar tractor is a little small but we believe that the ease of transport and the speed with which it can be made ready for use on the fire line more than make up for this limitation. The operator must be efficient and must understand and take care of his machine as the work is extremely hard on machinery.

More protection for the machine and operator are needed, and the narrow gage on our machines materially limits the percentage of slope upon which we can operate. The machines, however, justify themselves on the slash-disposal operation alone, but at the same time they provide for fire control work a protection force which would not otherwise be available.

FOREST PROTECTION ADOPTS "BLITZ" METHODS

Francis M. Burke

Forest Area Supervisor, Wisconsin Conservation Department

With fire crews hard to recruit, rangers turned to mechanization. Now 2 or 3 men do the work of 50.

Forest fire suppression in Wisconsin just isn't what it used to be!

Prior to and during the early thirties, a fire call meant the forest ranger hustled his old "jalopy" from the garage, hastily threw on an armful of shovels, another of grub hoes or mattocks, a few back-pack water cans, and a jug of drinking water, slammed the door, and was off on his prearranged route to assemble his scattered fire crew of townspeople and settlers. Then off to the scene of the smoke as rapidly as the poor roads and trails of the day would permit.

In those days, persons residing in wild land areas expected to be—and usually were—called to assist the ranger when smoke from a forest fire rolled across the horizon. Manpower was available in considerable numbers and the economic conditions at the time were such that the low fire fighter wages were sought by many.

Upon arrival at the fire, the ranger unloaded his crew, distributed hand tools to each, and assigned them work at the burning edge of the running fire. Slowly and laboriously they proceeded to bring the fire under control. After the fire was knocked down, a control line at the outside edge was usually hand dug to mineral soil, thus confining the fire. Following this the crew worked at mop up on the burning interior by watering down burning stumps, logs, and other forest debris or covering them with cold, damp, mineral soil.

Delay in assembling a crew, the slow method of control, and the ever-present confusion when large numbers of persons are involved, all contributed to increased numbers of major fires.

As small fires became large, the services of more fire fighters were required. Greater numbers of supervisory personnel were needed to adequately apply the efforts of the fire fighters. Transportation to and from the fire as well as providing meals became costly and difficult to perform. Reconnaissance on the fire usually was accomplished by cruisers and scouts. Communication was handled by runners. Fire control practices and procedures of the day were the best possible but certainly not adequate to confine the many fires which occurred to small burned acreage.

The legal responsibility of a Wisconsin citizen to assist in forest fire suppression has not changed but the forest protection division of the conservation department is making every effort to minimize its need for large numbers of untrained, unskilled laborers for fire control purposes. The economic picture has changed so that it has become increasingly difficult to hire individuals at the low fire fighter wage when this means taking them from better pay employment.

The present-day trend is to hire small crews seasonally, locate them strategically near the hazard and high-risk areas, give them a complete short course in fire behavior and control practices, outfit them with equipment and machines especially designed to move rapidly to any fire area and quickly knock down and mop up all fires when they are small, send them back to their base to stand by for the next fire call.

To accomplish this "blitz" method of control we have late model trucks outfitted with tool boxes, water tanks, and power take-off pumps with which water may be applied to the fire edge from the truck tank supply. In addition we have small, narrow, crawler type tractors, readily maneuverable in wild land areas, which tow our middlebuster fire plows and thus rapidly establish control lines to mineral soil at the burning edge of the fire. Tractors also are equipped with water tanks and pumps so that the burning edge of a running fire may be cooled down with water at the same time control line plowing is done.

Three-man crew operating tractor with middlebuster plow and water-spra equipment.

Tractors and plows are easily and quickly loaded on tilt-be trailers for over-the-road transportation by towing behind the large trucks. Loading or unloading consumes but a matter of seconds.

In addition to the machines mentioned, we now use small tractor equipped with bulldozers, water-tank trailers capable of transportin large volumes of water to fire areas, small portable pumpers with fir hose lines to facilitate mop-up work, and FM radio to provide com munications between field men and their headquarters or with othe supervisory personnel on major fires.

For scouting and reconnaissance work and to aid in directing groun suppression forces, we employ a skilled observer in our airplane. Th plane is radio equipped, making possible immediate and positive com munication to field men below. With this arrangement, proper machines are assigned where most needed. The result is faster and better control.

We have recently received our first 4-wheel-drive power wagon trucks. These vehicles are capable of moving over terrain which heretofore has been inaccessible to other trucks. We believe that with these trucks we can offer speedier fire control to isolated areas and also when road conditions are poor. They will be outfitted with water tanks and take-off pumps so that a small crew may take suppression action on fires.

In every instance, we consider chiefly apparatus which can be efficiently operated by a small crew. Our tractor and plow units can each establish as much control line as 50 men using hand tools in the same time interval. Our blitz water tanker units can apply water to equal the efforts of 50 men using back-pack cans for knocking down the burning edge of a running fire.

It is not uncommon for a crew of two or three men to proceed to the scene of a fire as the initial attack crew, rapidly suppress the fire, and return to their station without employing any emergency assistance. Delays in collecting large numbers of workers are eliminated in this method of attack.

During the 1947 fire season, 54 of 239 fires in one of the 4 existing forest protection areas were suppressed entirely by ranger crews without the aid of hired labor. On the remaining 185 fires, a total of 624 men, or an average of 3.3 men per fire, were hired to assist in actual suppression work. On many of these fires, men were hired only to patrol the burn after the running fire had been stopped.

Our fire action plan schedules how apparatus, machines, and supervisory personnel will move to any major fire area. Equipment of the particular fire district will be called first and that in adjacent districts or from our Tomahawk headquarters will follow if needed. Within a short interval our airplane is available for aerial reconnaissance and observation work, and radio communication can be functioning to all parts of the fire.

This trend toward fighting forest fires with mechanical devices will not, in fact cannot, completely eliminate our future need for the services of emergency fire wardens, key cooperators, and numbers of fire fighters on major fires. Our suppression commitments are so widespread that machines will never be able to entirely replace our manpower needs.

Your Wisconsin forest fire control program is in the hands of a fast-charging, hard-hitting group of rangers and their aides. An occasional fire may become temporarily out of control and burn over an appreciable acreage of valuable forest growth but by far the most fires will be put out before the general public knows they exist.

825099—49——2

THE RATE OF SPREAD—FUEL DENSITY RELATIONSHIP

W. S. Davis

Forester, Region 2, U. S. Forest Service

During a recent consideration of the value of fuel reduction as a fire control tool in the Rocky Mountain Region, a question was raised as to whether the density of fuel had any effect on the rate of spread of grass fires. The relationship between the rate of spread and factors such as wind, fuel moisture, relative humidity, and topography has of course been reasonably well established by earlier experiments; but no data could be found covering the problem in question. Casual observations of the behavior of prairie fires had created in some the belief that a fire would roll through sparse grass with the same velocity it attained in denser stands, although admittedly with a lesser intensity; whereas others held that a reduction in fire intensity would also lead to a slower rate of spread. To settle this interesting difference of opinion, it was decided to conduct some controlled burning on the Nebraska National Forest, where the rolling sand hill grasslands provide a good continuity of forage conditions.

Possibly the reason for the lack of data on the relationship between fuel density and the rate of fire spread lies in the fact that there is no convenient yardstick for measuring fuel density. In the Nebraska experiment it was decided to use the forage utilization of variously stocked range allotments as such a yardstick.

Two adjacent grazing allotments were then selected in gently rolling terrain. One showed an average forage utilization of 0.6 animal months per acre; the other was stocked only half as heavily. These two allotments were separated by a drift fence and a marked change in vegetation density was indicated on the fence line.

The forage consisted of a well-cured mixture of the following:

Turkeyfoot (sandhill bunchgrass)	*Andropogon hallii*
Dropseed	*Sporobolus* sp.
Prairie sandgrass (sand reed grass)	*Calamovilfa longifoli*
Lovegrass	*Eragrostis trichodes*
Sedge	*Carex* sp.
Hairy grama	*Bouteloua hirsuta*

Parallel plots, 500 feet in length and 100 feet wide, were establishe on each side of the fence and surrounded by adequate firebreaks.

The test was conducted in November. Some variance in tempera ture and relative humidity was noted, but the wind held at a stead 16 miles per hour throughout. The fires were allowed to run with th wind, and were set so that the lightly grazed and heavily grazed plot burned simultaneously, affording a good comparison. Stop-watc readings were taken on the rate of advance of the head of the fire i each plot. Since thermocouples were not available, the intensity c the fire was gaged by measuring the average height of the flames.

Portion of test area. Utilization: approximately 0.6 animal months per acre on left; approximately 0.3 animal months per acre on the right.

Finally, the fire was allowed to run with the wind from the lightly grazed to the heavily grazed area, in order to discover whether a rolling fire would be affected by thinner fuel.

All tests showed conclusively that the reduction of fuel density has a marked effect on both the rate of spread and the intensity of grass fires. Specifically, the average results were as follows:

Area:	*Frontal advance of fire (feet per second)*	*Intensity of fire (average height of flames in feet)*
Lightly grazed (0.3 animal months per acre)	1. 56	5
More heavily grazed (0.6 animal months per acre)	0. 53	1

Under the test conditions, in other words, the residual density of grass as represented by a utilization of 0.3 animal months per acre will allow potential fires to advance three times as fast and with five times the intensity of fires in areas that have been grazed twice as heavily.

The result of the test is further proof that the principle of fuel reduction is sound, from a suppression standpoint. This finding of course, does not alter established Forest Service policy of managing the range primarily in accordance with the needs of the soil and vegetation rather than as a means of reducing fuel hazards.

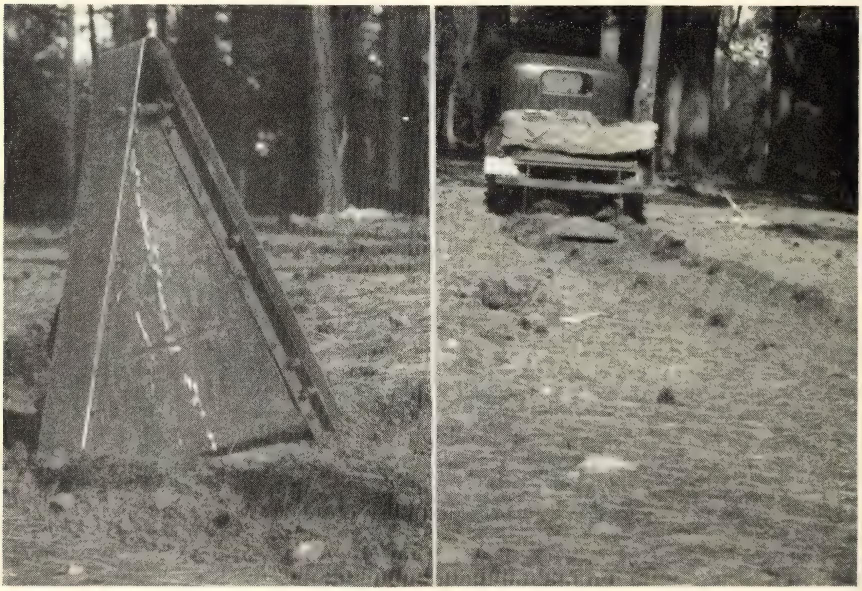
THE SUMMERFIELD V-SCRAPER—A FIRE LINE BUILDER FOR OPEN PINE FOREST

J. A. Egan

District Ranger, Coconino National Forest

On the Long Valley District of the Coconino there are 175 fires a year (10-year average). It is not unusual for a single storm to start 20 to 30 fires. Under these circumstances anything that will increase the efficiency of a fire guard is mighty valuable. The V-scraper, developed by General District Assistant Henry Summerfield, is just such a piece of equipment. Under ideal conditions a fireman with a combination fire tool can build about 10 chains of fire line per hour. Under the same conditions (anywhere that a pickup can go) the V-scraper behind a pickup with a four-speed transmission will build *2 miles of fire line* per hour.

When the fireman arrives at the fire he unloads the scraper, hooks it to his bumper or trailer hitch, throws on a few boulders or a dozen shovels of dirt, and starts around the fire making a 30-inch fire line as he goes. On rocky ground or where there is reproduction there will be a few skips in the fire line. One man with a combination fire tool can complete the line where the scraper skips—or if the fireman is alone he will have to stop occasionally and check the line to see that it is clean—down to mineral soil.



Bottom view of V-scraper, showing construction; and V-scraper in action.

Just how many fires, that might have become large, have been kept small by the V-scraper would be hard to guess; but it is safe to say that each year two or three potential class D fires have been kept down to B or C size and a dozen potential class B's remained as class A's. The savings on this one district can be estimated at several thousand dollars a year.

The few materials needed to build one of these scrapers are one used 6-foot grader blade, 4 feet of 1-inch angle iron, a 30-inch square of old roofing tin or galvanized iron, one 3/8- by 6-inch carriage bolt, nine 3/8- by 1-inch carriage bolts, 6 feet of 3/16- or 1/4-inch chain. Place the grader blade in a vice about 6 inches from the middle and heat the middle with an acetylene torch. Have a second man pull the end of the blade around to form a V with the ends about 30 inches apart. Holes can be drilled or burned in the angle iron (to fit the holes that are already in the grader blade) and punched in the tin. Attach the chain low inside the scraper so that it pulls over the top of the point of the V and keeps the front of the scraper in the ground.

The accompanying photograph of the bottom of the scraper gives enough details so that one can be built without difficulty.

Reverse Flow Fan for Fire Plow Tractors.—On the Francis Marion National Forest we have always been bothered with our fire plow tractors running hot because of radiators clogging up with debris. Dry pine needles, leaves, and grass are sucked against the front of the radiator despite any kind of supplemental screen that we have been able to devise. Air circulation through the radiator can be retarded enough after only 2 or 3 hours of plowing fire line to make the motor overheat, whenever the weather is warm and dry. It is hard work to clean trash out of a radiator, especially on the fire line.

Ranger John T. Koen wanted to try a reverse flow fan. A number of tractor operators and salesmen insisted that a reverse fan would not circulate enough air to keep the motor operating cool. Nevertheless, we bought one for an International TD–9 in March 1948 for $5.60.

Although we have not had any fires on extremely hot and dry days since then to give it the "acid" test, we have used this tractor with reverse flow fan enough on prescribed burning to make us think we have solved our problem. The fan seems to push enough air through the radiator to keep it cool. The motor has not overheated. There is no clogging by debris on the radiator on the fan side. Whether the motor hood sides are on or off makes no apparent difference in air circulation or resulting heat of the motor.—C. S. HERRICK, JR., *Assistant Forest Supervisor, South Carolina National Forests.* (Reversed fans on tractors have also been used successfully in several instances in western regions.—Ed.)

VERTICAL WIND CURRENTS AND FIRE BEHAVIOR

JOHN S. CROSBY

Forester, Lake States Forest Experiment Station[1]

Forest fires are known to behave in a variety of ways, sometimes in quite unexpected ways. Prompt suppression requires that the fire boss, in estimating the probabilities of control within the allowable period, consider factors affecting the behavior of the fire as well as those fixed by the site.

The important variables not determined by the specific location are the weather factors, primarily moisture and wind. Estimates of fuel moisture and winds are made on the basis of weather forecasts, or through a knowledge of normal daily variation and past experience based on observation of weather reactions in the locality. Often the weather forecast must be interpreted in terms of local topography, or proximity to large water bodies, so personal observation may be invaluable.

Although fuel moisture is an important factor, the purpose of this paper is to point out certain wind features, particularly those in which vertical currents are concerned, and to present a few general rules for recognizing the probability of their existence. On the ground, the best information available about wind is its surface velocity and direction, both of which may be constantly changing, whereas little if anything is known of the action of the wind above the immediate surface and which may have considerable effect on the fire.

Wind is air in motion. The direction of motion taken is almost unlimited. Near the ground the wind customarily blows in gusts and lulls, seldom as a steady even flow. Because it cannot be seen, it can only be noted by its effect on various objects, and hence it is difficult to obtain a complete picture of the variations that characterize air flow. Watching the drift of smoke is one way to observe its motion; this is like observing somewhat similar currents in a river. Both water and air are fluid, though water is more limited in its freedom of motion. The water swirls around and over rocks, makes eddies around land projections, and tumbles over falls. It exhibits motion in many directions besides down stream. Likewise, air moves in a turbulent fashion near the ground while still following a general course.

The general flow of air is determined by the air pressure gradient and is modified by the effect of the earth's rotation and the friction caused by the passage of the air over the earth's surface. The direction becomes clockwise around high pressure centers with a slight drift outward, and counterclockwise around low pressure centers with a slight drift towards lowest pressure. At any fixed location

[1] Maintained at the University farm, St. Paul 1, Minn., in cooperation with the University of Minnesota.

the wind direction changes as the pressure systems migrate and take up new positions in respect to that point.

Many reactions are superimposed on the flow of air, particularly near the ground, to modify the pressure flow. Aloft the wind is stronger, and more steady, being changed only by strong reactions.

Up and down air currents may exist in the lower atmosphere in a great variety of intensities and steepness of rise or fall. Small eddies in a light wind may be only a few feet in depth, whereas strong convection currents may extend several miles into the atmosphere, or the gentle lift caused by a warm front may amount to 10 feet in a mile, but extend over 1,000 miles.

At ground level the wind tends to parallel the surface; that is to say, because the wind cannot penetrate or go through the solid earth, its larger up and down currents must change to a motion along the surface on reaching the surface, though the direction may be variable, and small eddies still persist.

Sustained vertical motion of the air is more prominent at some distance above the surface where, of course, it is more difficult to observe. When a vertical motion, such as an eddy or convection current, is superimposed on the existing wind, the result is alternately to speed up and slow down the wind making it gusty and stronger.

The stronger the horizontal wind, the more turbulent it becomes in its passage over a rough surface, thus creating stronger eddies and more gustiness with frequent changes in direction. Turbulent, gusty winds affect fire behavior by fanning the fire in spurts from varying directions, and by carrying heat and embers to fresh fuels.

The motion of the air is also strongly affected by the heat it gains from the earth on sunny days. Air in contact with the ground then, because of the additional heat, becomes lighter than air above and tends to rise. The rising warm air sets up convection currents. A forest fire also sets up such currents locally because of the intense heating of the air by the fire.

The earth's surface is not uniformly heated. Water surfaces are cooler than land, and forested land cooler than exposed soil or rocks, so the surface air is not of uniform temperature. Warmed air tends to rise in streams usually localized over the warmer areas, or hills may help to start the warm air upward.

Down-drafts occur as complements to up-drafts. Both currents have their effect on a forest fire. While an up-draft in a favorable atmosphere has the effect of pulling on the rising smoke column, thus increasing the air feeding into the fire, the down-draft increases the surface wind velocity, making it more gusty and turbulent.

Once started, convection currents may be accentuated or depressed by the atmosphere, depending on its condition of stability. If stable conditions exist (where the temperature decrease with elevation in the atmosphere is slight) the convection currents will be damped. However, in relatively unstable air (where decrease of temperature with elevation is great) convection currents are increased in speed and depth. Convection currents sometimes rise to 8 or 10 miles in the atmosphere and develop great vertical velocities.

With night-time cooling, the air is stabilized at low levels, and the convection currents subside. This change is a part of the daily variation in stability. In flat country the wind then dies down. In

mountainous country the wind stops flowing up-slope and begins to flow down-slope. Along larger water bodies the daytime landward breeze changes at night to a seaward breeze. These changes are normal only when the pressure gradient is weak.

The stability of the air layers both near the surface and aloft greatly influences fire behavior. Very large fires generate intense heat and may enable the heated air to penetrate moderately stable layers and join or set up vertical currents aloft, thus giving a new impetus to the fire, causing it to flare up unexpectedly. A study of large fires in relation to air stability conditions aloft might throw new light on unexpected fire behavior, and provide a new tool for better forecasting fire behavior.

When there is marked air stability even during the daytime, the height to which convection currents may rise is of little consequence, and the diurnal variation in wind is not important. Thus, a strong daytime wind may not die down much at night because it is driven by the pressure gradient alone, and it will decrease only as the pressure gradient decreases.

These considerations are useful only insofar as one is able to plan for them and hence a few very general rules may be helpful.

While the actual stability of the air and the pressure gradient are basic, they are not subject to convenient observation at a fire. Indirectly, however, the condition of stability shows itself in several ways.

Cloud formations.—Cumulus type clouds are always an indication of rising air currents, and often indirectly of instability. In mountainous country, the rising currents may be due to lift over a ridge, while in level country it is almost always a result of convection if not associated with a front. For these clouds to form there must be sufficient water vapor present in the rising air so that it is cooled to its saturation point before the lift ceases. If the cloud bases are low it is an indication of abundant moisture; if high, water vapor is scarce. This condition is indicated at the ground surface by high or low relative humidity respectively. The height of the cloud tops indicate the height to which the convection currents extend, and show also the stability of the air as the currents do not penetrate stable air layers. Flat-topped cumulus clouds, therefore, indicate stability aloft.

Often, however, vertical currents exist without formation of cumulus clouds as the water vapor content is so low that it cannot be carried high enough to condense. Under such conditions, when the sky is mostly clear, evaporation is speeded, resulting in faster drying of fuels.

When relative humidity is low and temperature high, strong currents may exist to considerable elevations without clouds forming. A further check can be made by watching the rise of temperature during the morning. A sharp rise early that flattens out and remains high substantiates the prospect of deep vertical currents, assuming nearly clear skies. Small whirlwinds or dust devils also indicate unstable conditions, though they may exist only near the surface.

Thunderstorms and very large cumulus clouds indicate instability extending to great heights with strong vertical currents. Thunderstorms with high bases may be dry storms, that is, the rain evaporates into the air before it reaches the ground, and hence lightning strikes are more dangerous.

Stratiform clouds (fog-like clouds or layer clouds) indicate stable conditions at least at the level of the clouds though stratocumulus may often form in turbulent surface air even though the turbulence is shallow. In general, the lower the stratus clouds, if they persist, the more stable the air, and the less possibility of vertical currents. Low stratus clouds in the morning, however, often are a better indication of good moisture conditions than of continued stability during the day for they may have formed in a shallow layer of stable air that will rapidly change to an unstable layer during the heat of the day.

Visibility.—Good visibility is often a sign of unstable air in which vertical currents may develop. In unstable air the impurities are carried aloft and away, while stable air traps impurities and holds them in a shallow layer of air.

Air mass.—Cool air masses following cold fronts during the fire season east of the Rockies tend to rapidly develop instability in passing over warmer areas. This instability at first is not deep, but increases with time. The cool air is also dry air, and visibility is good. It is usually recognized as coming in with fresh northerly winds.

Winds.—Gusty winds with a noticeable decrease in velocity at evening indicate the possibility of strong convection currents during the day. Turbulence and gustiness are more readily started in unstable air. Such gusty winds usually are accompanied by frequent changes in direction. The direction may vary through 45 or more degrees rapidly, back and forth, or more moderately within periods of an hour or so.

825099—49——3

HOUSING REMOTES FOR VHF RADIO

North Pacific Region

U. S. Forest Service

Postwar expansion in the use of radio in the North Pacific Region developed a need for inexpensive housing in which to mount radio equipment located remotely from its point of operation.

Most of our new radio equipment is in the very high frequency (VHF) range (30 to 40 megacycles) which is quite line-of-sight in its propagation. Many of the headquarters in which we wish to set up radios are down in holes or otherwise shielded by terrain so as to be ill suited to good transmission or reception of VHF signals. This difficulty may be overcome by setting up the radio antenna, transmitter, and receiver on a convenient high point and operating the station from the headquarters it serves over a pair of telephone wires.

Radio equipment of the kind used for headquarters stations usually comes in a vertical floor mounted cabinet about 24 by 24 by 74 inches with doors for servicing on both front and back. We decided that the housing need be no more than is necessary to protect this equipment adequately from the weather and vandalism. We also required that the housing be semiportable for ease of installation and to comply with regulations governing installations on leased or other nongovernment land. The building also had to be cheap and require a minimum of maintenance.

Out of these specifications our shop personnel and radio engineer developed a welded steel building approximately 3 by 3 by 6½ feet with arched roof and with doors on two sides opposite the doors of the radio cabinet which it houses. One-quarter inch steel plate is used for the bottom, arched roof, and two sides of the building. The remaining two sides are composed largely of watertight steel doors salvaged from the deck houses of scrapped ships. Air inlets are provided low down in the two sides and a thermostatically controlled exhaust fan mounted in the overhead. A receptacle for receiving the 1½-inch pipe that supports the antenna is welded onto the roof. Angle iron flanges are welded to the bottom and drilled to receive hold-down bolts for mounting on a concrete slab or other convenient foundation.

The entire structure weighs about 1,100 pounds and can be carried in the back of a pickup truck. Utilizing the ships' doors at junk prices of $7.50 each, the houses cost $242 complete with exhaust fan, thermostat, and 18 feet of 1½-inch pipe for antenna support. They could be fabricated by any small welding and metal shop at that price if convenient to a shipyard wrecking area where the doors can be obtained.

HAULING CONSTRUCTION MATERIALS FOR LOOKOUT TOWERS BY HELICOPTER

MASON B. BRUCE, *Assistant Supervisor*, and CARL H. CRAWFORD, *Forest Engineer, White Mountain National Forest*

The White Mountain National Forest had the problem of transporting some 26,000 pounds of building materials and equipment to a new tower location on Mount Pequawket (elevation 3,268 feet) near Conway, N. H. The job involved building a 3½-mile tractor road to within a half mile of the summit and then back-packing the materials from there to the top, the summit of Pequawket being so ledgy as to make the use of horses or tractors impractical. Lack of cover and high winds keep the snow pretty well blown from the ledges and make the use of a snow road to the top out of the question. After careful study, it was estimated that the transportation job could be done for $3,033.

It was decided to investigate the possibility of hauling the materials to the summit by helicopter. The difference in elevation between the nearest roadside clearing and the point of delivery was 2,500 feet; airline distance was 2¼ miles. The material to be hauled varied in nature from treated timbers 2 inches by 10 inches by 20 feet, to metal window casings measuring about 3 by 4 feet, and bulky cartons of insulating bats measuring some 2 by 4 by 4 feet. A quantity of sand and cement was also included.

Bids were solicited from all known helicopter owners in the New England area. New England Helicopter Service, Inc., of Hillsgrove, R. I., agreed to do the job at a uniform rate of 9 cents per pound, which brought the cost of transportation to $2,372.49 for 26,361 pounds. Loading and unloading were done by Forest Service personnel under the direction of the pilot.

Two helicopters were used, Bell models 47B (1947) and 47D (1948). Each was equipped with two tubular aluminum crosspieces attached to the landing-gear supports. Lumber and other long and bulky material were secured firmly to these cross members. Items smaller in over-all size were carried in the cab. There was no significant difference in the results obtained from the two models used.

A small field, less than a quarter of an acre in size, was ample for a loading point. For a landing point on the top of the mountain, it was necessary to level off an area roughly 25 feet square with small stones and dirt. The particular helicopters being used had no wheel brakes and could not land on sloping surfaces. No clearing of trees or brush was necessary since the mountaintop was barren.

Loads varied from 250 to 425 pounds, depending upon temperature and wind. Carrying capacity increases as temperature drops, and winds up to 40 miles per hour have a definite favorable effect. Average loads, exclusive of pilot, were 300 pounds. A loading crew of two men

Loading crew in operation. Lumber was secured with straps; small materials were carried inside.

at the foot of the mountain sorted, weighed, and bundled the materials. An unloading crew of two men at the top detached the loads and stored them. These were the minimum size crews necessary at each point. At times, they were hard pressed to keep up with the flow of materials.

Helicopter taking off with full load.

During the best day of operation, an 8½-hour day, 13,000 pounds were carried by the Model 47D. Round trips, including loading and unloading, averaged about 12 minutes each. Several individual loads were completed in as little as 8 minutes each. Extra help was necessary in loading and unloading during this day.

Some unusual cost was involved by the New England Helicopter Service, Inc. The carrying cross members were fabricated for this particular job and experimental expense was entailed in their development. The Helicopter Service had to carry on rather time-consuming negotiations and tests with the C. A. A. and their insurance company before permission could be obtained to go ahead with the operation.

Officials of the Helicopter Service reported the operation to be a practical one and indicated active interest in bidding upon similar jobs. This was the first operation the concern had attempted in mountainous country.

The results of the project indicate that helicopters are practical for transporting certain types of construction material and equipment to points made inaccessible by elevation and lack of roads. Their use should be given serious consideration in planning transportation to such locations.

Aerial Fire Detection.—During the last week in August and the first week of September 1948, a series of dry lighting storms occurred on the Poudre District of the Roosevelt National Forest in Colorado. Five fires, the forerunners of 12 in a 6-day period, had been started. These had been located by lookouts or by local people and were in all stages of being suppressed.

On August 31 the lookout on West White Pine Mountain spotted what he thought was a smoke in the vicinity of Crystal Mountain. Local ranchers were immediately dispatched to the area but could not locate the fire. On September 1, I hired a plane from a local air service company to fly over the area in an endeavor to locate the lost fire. Upon approaching the locality where the smoke had been seen, we ran into another dry lightning storm. The air became exceedingly rough and we were forced to climb to an altitude of 13,500 feet.

While we were flying at this altitude, in the Luscombe two-place plane, a bolt of lightning seemed to flash past, and almost immediately we saw a large ball of white smoke puff up from a ridge top south of Crystal Mountain. Immediately following this smoke a tree burst into flame. The plane was not equipped with a radio so upon determining the exact location of the strike, we headed for the airport near Fort Collins. Thirteen minutes after the strike had occurred it was reported to the supervisor's office and suppression action was immediately started. The fire was held to an area of approximately 50 square feet.

The area in which the strike occurred was only indirectly visible from the nearest lookout tower 6 miles distant, and the lookout failed to see the smoke until long after suppression action was started. The use of a plane in this case quite likely prevented the fire from developing into a much larger one, since fire danger was high.

In areas where a regular air detection system is not set up or justified, a short patrol after each dry lightning storm may well be worth the cost.—Howard W. Stagelman, *Forester, Roosevelt National Forest.*

MOBILE REFERENCE MAP

Ed. J. Smithburg

District Ranger, Los Padres National Forest

Need for a readily accessible map for reference when learning a new district led to the use of a map mounted on a window blind above the windshield on a pickup. The arrangement proved so handy that the writer has used one for about 8 years, transferring it from car to car, and putting on new maps when changes of station made it necessary. Time saved at intersections has been considerable, and the map has proved of value for follow-up dispatching while enroute to a fire.

The cost of the blind is negligible; installation is easy, but must differ slightly for each type of vehicle. The regular brackets furnished with the blind work very well. It is usually possible to use two of the machine screws holding the windshield channel to hold the forward edge, and a couple of metal screws to hold the rear edge of the brackets. When the blind is in place it is well to squeeze the bracket together so the blind won't jump out. Leave the stick at the bottom of the blind longer, so the blind can't accidentally unroll and spin. Gluing the map to the blind is not necessary. To install the map on the blind, unroll both, place the map on top of the blind and

roll snugly together. Fasten the bottom edge with scotch tape and staples, then unroll and fasten the top similarly. Do not fasten the sides. Tension when pulling the map down keeps the map smooth and straight, and the blind prevents the light from shining through.

We plan this year to equip all tankers with water maps showing the location of all water supply sources, together with the amount, and method of drawing water. All routes of travel will be shown, including accessible ridge tops. All patrolmen will be equipped with human use maps showing points of public contacts and types of hazards present.

Accident Experience of Smoke Jumpers, Region 1, 1948.—Clyde Blake, safety officer for Region 1, reports that 142 jumpers completed training and 758 jumps were made, 580 training, 164 on 41 fires, and 14 on rescue mission. Only 3 disabling injuries occurred. Two of these, a sprained foot and a sprained back, were the results of hard parachute landings; the third, a broken leg in a felling accident.

Accident Experience of Smoke Jumpers, Region 4, 1948.—A report of the accident experience of smoke jumpers at 2 bases, McCall and Boise, revealed that in 500 jumps by 63 jumpers only 3 accidents occurred. Two of these were minor jumping accidents involving no lost time that occurred during training jumps. The third, resulting in broken bones, happened during a jump to a fire and caused a loss of 144 man-days. Statistics were given for age groups as follows:

Age:	*Jumpers*	*Jumps*	*Accidents*
24 and under	47	403	3
25–29	13	80	0
30–34	2	10	0
35 and over	1	7	0

One of the minor acidents occurred to a jumper weighing less than 150 pounds; the other two, to jumpers weighing more than 150 pounds. At the McCall base there were also nine minor accidents such as ax and saw cuts and bruises. Two of these occurred in fire suppression work, the others on project work.

Safer Single Edge Brush Hooks.—Marvin D. Hoover of the Southeastern Forest Experiment Station, in a good suggestion on single edge brush hooks says, "Very little or no cutting can be done with the extreme point of the blade or the heel, and these edges become very sharp with repeated filing of the blade. At the same time these are the parts of a blade most likely to cut men. We have dulled about one-half inch back from the point and rounded and dulled the heel.

"In actual use the workers found no objection to this change and we all believe it is much safer."

The Forest Service specification for single edge brush hook, revised in 1947, includes this safety provision.

STRIP MAP FOR USE IN OBSERVATION PLANE

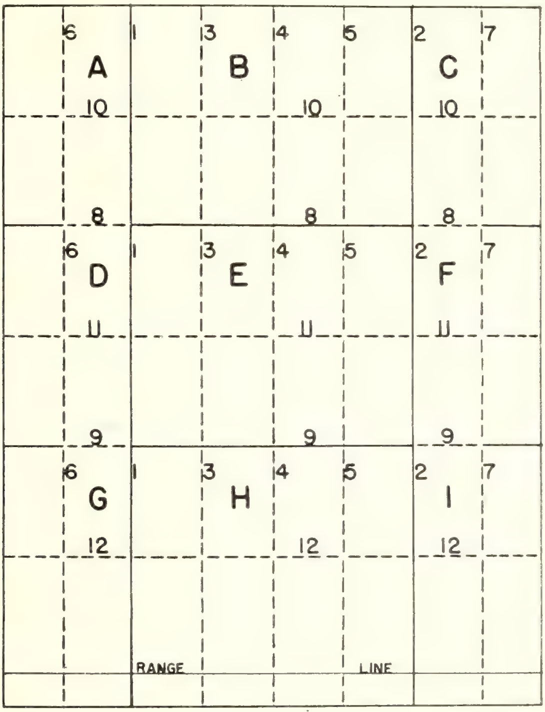
T. A. Pettigrew

Control Dispatcher, Trinity National Forest

For 3 years the Trinity Forest has been using strip maps in plane observation while scouting fires, etc. They are prepared from ½-inch scale forest maps and have been found convenient and serviceable. The instructions for cutting, folding, and mounting should be followed step by step.

1. Mark off map vertically into three strips with the center strip 1 inch wider than the combined widths of the outside strips. The outside strips should be same size. Make these marks solid lines, as they will be cut later; number the lines 1 and 2 as on the accompanying drawing.
2. Draw three vertical broken lines through the center section dividing it into fourths, number lines 3, 4, and 5; later the map will be folded on the broken lines.
3. Draw a vertical broken line through each of the outside strips, one-fourth inch off center toward the outside of the map. These lines will be numbered 6 and 7. This operation completes the vertical division of the map.
4. Measure the distance from the first horizontal line above the range numbers at the bottom of the map to the top of the map and divide into three equal sections by drawing two solid horizontal lines between vertical lines 1 and 2 and from lines 6 and 7 to the edges of the map. Complete these lines by drawing broken lines from vertical lines 6 to 1 and 2 to 7. These lines are numbered 8 and 9.
5. The map will be cut into nine sections so at this time letter the sections; the cuts will be made on lines 1, 2, 8, 9. Starting at the upper left corner letter the sections A through I.
6. Divide each of the first two horizontal tiers of sections, A, B, C and D, E, F, with a broken horizontal line in the center of the sections. Number these lines 10 and 11.
7. Draw a broken horizontal line through the bottom tier of sections, G, H, I, halfway between the line above the range numbers and the top of the section. This is line number 12. This completes the marking of the map.
8. Cut the map on vertical lines 1 and 2.
9. Remove the center strip of the map; slide the two outside pieces together and join by using a strip of 1-inch linen tape on the back of the map.
10. With the face of the map up, fold the edges of the map up on lines 6 and 7.
11. Cut the solid portions of lines 8 and 9 on the two outside strips and also on the center strip.
12. Take the outside strips which have been fastened together and fold up on lines 10, 11, and 12, and fold back on lines 8 and 9.

13. Using a manila folder for a cover, open the folder and place the outside strips with horizontal line 10 on the fold of the manila folder. Take four pieces of 1-inch linen tape, 7 inches long, fold them $2\frac{1}{2}$ inches from the end, and stick the glued sides together. This is done to prevent this part of the tape from sticking later. Fasten the exposed glued edges to the back of the map between lines 6 and 7. Make sure line 10 is parallel to the fold of the cover and staple the top end of the four pieces of linen tape to the folder.



Method of marking, cutting, and folding map in preparing strip map; cut on solid lines, fold on broken lines.

14. Place line 12 of the outside strips over the fold in the folder and staple the bottom edge of the map between lines 6 and 7 to the folder.

15. Fold the bottom sections of map attached to the folder to expose sections A and C. Unfold these sections to their full width.

16. Take section B and with it folded up on line 4 lay this fold on the joint of lines 1 and 2 and fasten it in place with a strip of transparent scotch tape along the entire length of the joined edge. Now fold this section to the other side and run a strip of tape on as before.

17. Now fold the edges of sections A, B, and C up on lines 6 and 7 and back on lines 3 and 5 and open at line 4. Now fold up on line 10 to expose sections D and F.

18. Insert section E using the same method as applied for section B.

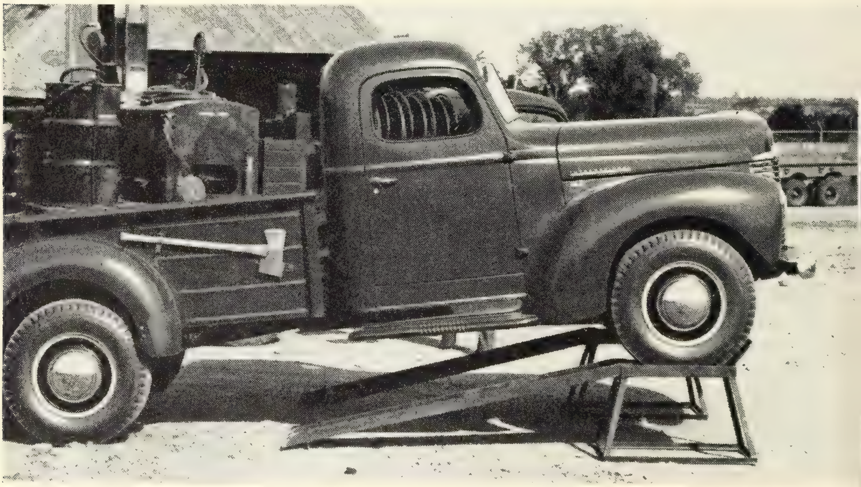
19. Fold up on line 11 and insert section H. Fold up on line 12 and this completes the operation.

FIELD EMERGENCY SERVICE RAMPS FOR VEHICLES

L. K. Gardner

Inspector of Engineering Equipment and Materials, Region 5, U. S. Forest Service

In fire camps and other temporary work camps, it is difficult to properly service those types of vehicles, such as sedans and pickups, which have limited ground clearance. The serviceman is forced to work at complete disadvantage and the quality of service performed is expectedly inadequate. To facilitate the lubricating of vehicles Region 5 has developed portable service ramps.

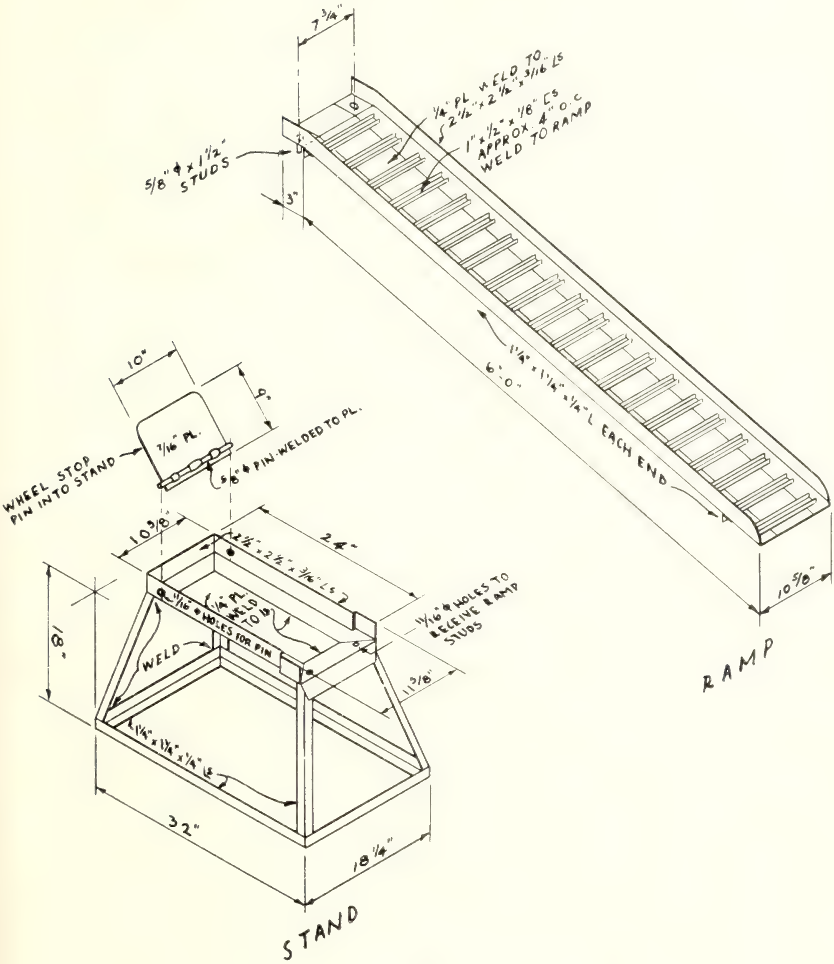


Ramp and stand in use.

These ramps, upon which one end of the vehicle can be driven, will provide adequate ground clearance. Raising one end of the vehicle 18 inches permits freedom of movement and greater accessibility to all the under parts.

In use, the ramps are set up in the most suitable location, preferably level, hard ground, and spaced in accordance with the tread width of the vehicle. Either end of the vehicle can then be run upon them. Wheel stops prevent overrun and wide bases of the stands afford stability to prevent overbalance or upset. After one end of the vehicle is in position on the stands, the incline ramp can be temporarily removed to permit increased accessibility.

As a safety precaution, placement of blocks under the wheels on the ground is recommended to prevent possible rolling of the vehicle.



Portable emergency service ramp and stand.

The ramps are made in pairs, each consisting of a substantial stand and detachable incline ramp, forming a compact unit during transportation when not in use. Although purposely designed of light materials for portability, structural strength is adequate and safe for all ordinary purposes up to and including the front end of an unloaded 1½-ton stakeside. No attempt has been made in the design to accommodate dual wheels. The rear portion of a truck has sufficient clearance and exposal of parts to present no problem of accessibility.

In most instances, the ramps are set up alongside a luber unit. Service of a concentration of vehicles can be greatly facilitated with such a combination.

The ramps were originally devised for lubrication purposes, but it has been found that considerable advantage is offered for repair purposes, or for any reason the extra clearance is desired.

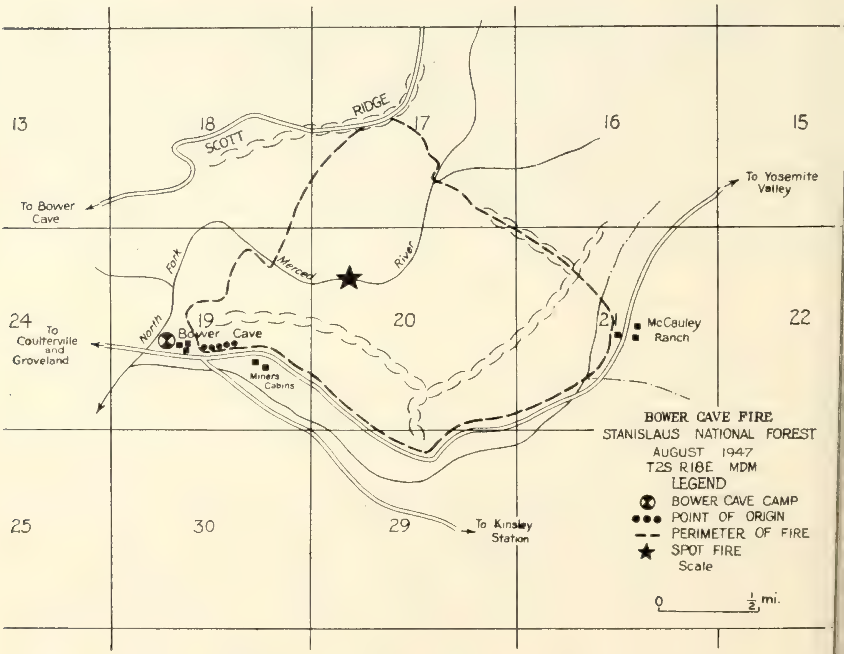
THE BOWER CAVE FIRE

Leon R. Thomas

Fire Control Officer, Sequoia National Forest

The Bower Cave Fire of August 13, 1947, on the Tuolumne Distric of the Stanislaus National Forest is being reviewed to show how a fast moving fire, which was burning in steep terrain and in heavy cover was readily and quickly controlled, after the first attack had failed by effective use of modern equipment, and by the local people anc trained Forest Service personnel working effectively as a team.

August is a most dangerous fire month in this area. The weathe is normally hot, fuel moisture is low, and rapid spread of fires can al ways be expected. At the time of this fire normal weather condi tions prevailed throughout the district and no important change were forecast. It is estimated that there was an up-slope wind of miles per hour blowing at the fire when the first crews arrived. I increased in velocity during the day but never blew hard. There i a normal downdraft at night with increase in humidity.



Map of Bower Cave Fire, Stanislaus National Forest, Calif.

Bower Cave, a former resort, is located near the old Coulterville-Yosemite road where the road crosses the North Fork of the Merced River. The ridge between Bower Cave and McCauley ranch and Scott Ridge to the north of the river have moderate to steep slopes and are covered with scattered ponderosa pine and black oak with a heavy ground cover of manzanita and scrub oak. Elevation ranged from 2,350 feet at Bower Cave to 3,400 at the higher reaches of the fire perimeter. The sets were on a grassy, pine-oak flat with the steeper slopes and heavier cover just to the north.

For many years there has been an incendiary problem on this part of the ranger district. Sets are always in high hazard types; and several severe fires have been the result. This fire appeared to be another of that type.

The first report was received in the district ranger's office at 9:25 a. m. August 13, 1947. The ranger, fire control assistant, and the district clerk-dispatcher were in the office when the report was phoned in by the caretaker at Bower Cave. He reported that there were several small fires burning on the upper side of the McCauley road between Bower Cave and the miners' cabins one-half mile up the road. The area is blind to all lookouts and not until 9:40 a. m. did the lookout on Pilot Peak report smoke coming up over the ridge that blanked out the area for him.

The Kinsley Station crew, being the nearest organized fire suppression crew, consisting that day of two men and a light pickup tanker, was immediately dispatched. They arrived at the fire at 9:48 a. m. The fire control assistant and one fireman arrived at 9:56 a. m.

The ranger station crew of two men and a tanker was dispatched as was the third organized fire crew on the district, the McDiarmid Station crew of four men and a tanker.

The district ranger helped the clerk notify the central dispatcher and a few local people and was at the fire by 10:05 a. m. with a radio-equipped pickup.

The Kinsley crew found five separate fires burning on the upper side of the road within a distance of about 100 yards. Two Pacific Gas & Electric Co. power line construction employees, who had seen the smoke while working on a nearby line, were already putting a line around the fire nearest Bower Cave. These two men corraled this fire, the smallest of the five, at about one-tenth of an acre in size. The Kinsley foreman left his one man on the second fire and attempted to handle the other three alone with the aid of the light tanker. These three fires were the largest of the five and were rapidly burning together. They were burning in the grass and pine needles and were working toward the steep slope above.

Little, effective control work had been accomplished on the upper four fires when the fire control assistant arrived at 9:56 a. m. He and the one man with him joined the Kinsley foreman in attempting to cut off the head of the main fire at the toe of the steep slope. The Bower Cave caretaker had also arrived and was assisting the foreman.

The fire was burning very hot and was spotting badly up the steep slope when the ranger arrived at 10:05 a. m. He fell in with the other men in attempting to cut off the head and control the spots. The fires which had now burned into one were just too hot to handle and the light tanker was ineffective.

By 10:15 a. m. it was fully realized that the initial attack had failed. The heavier tankers from the ranger station and the McDiarmid Station did not arrive until too late to be of value on initial attack.

The ranger and the fire control assistant made plans for and immediately started a flanking action to keep the fire narrow and possibly pinch it out on the ridge above, should sufficient help arrive soon enough. There was a very good possibility of control on top of the ridge above Bower Cave since once the fire reached the top it would have to burn along the ridge or downhill for a considerable distance. The cover was also lighter along the ridge and on the north slope.

The dispatcher was notified of the situation by radio and a request was sent in to the supervisor's office to have the fire and the area scouted from the air. Orders were sent in to get all the help possible from the local sawmills, woods crews, Pacific Gas & Electric Co. construction crew, and the local ranchers. Two 15-man district road construction crews and a 50-man district blister rust crew were also ordered. A fire camp was to be set up at Bower Cave. It was calculated that this number of men could corral and hold the fire on the ridge that afternoon with an estimated area of about 200 acres. After 10 a. m. the men began to arrive rapidly, as indicated by the number on the fire in the following tabulation:

	Men on the fire		
Time:	*Local labor*	*Forest Service personnel*	*Cumulative total*
9:25 a. m.	0	0	0
9:30	2	0	2
9:48	1	2	5
9:56	0	2	7
10:05	0	2	9
11:00	81	40	130
12:00	21	0	151

The forest fire control officer flew the fire at 11:15 a. m. in a conventional aircraft and reported to the ground by radio that the flanking action was making good progress and that it had a very good chance for success by the early afternoon.

At 12 noon the ranger and a local rancher scouted the ridge in front of the fire and kept in communication with an SX radio. At 12:16 p. m. the lookout on Pilot Peak reported a smoke in the bottom of the Merced River about one-half mile to the northeast of the original fire. In a few minutes the ranger could see the smoke from his position on the ridge. It appeared to be burning on both sides of the canyon and spreading toward Scott Ridge and the McCauley ranch as well as back toward the original fire.

The forest fire control officer again scouted the fire from the air at 2 p. m. The ranger in the meantime had gone around and scouted the new fire from the Scott Ridge side. Through radio discussion with the fire control officer in the plane and with the ground scouting information, it was determined that the fires would burn together before they could be controlled. It was then decided that both fires should be handled as one.

The cause of the spot fire was not determined. It may have been another set. No attempt was made to send men to it as it was spread

ing rapidly when first discovered and an initial action crew would have been ineffective.

It was realized now that control lines would embrace an area of a thousand acres or more and that a good deal of the line on Scott Ridge and the McCauley area was a bulldozer show. Additional tractors were ordered. Two D–7 caterpillars were walked to the McCauley ranch from a nearby Forest Service road construction job. One D–7 caterpillar was trucked in from another Forest Service road job on the district and a TD–14, the Forest Service fire stand-by tractor, was trucked in from the supervisor's headquarters. Two bulldozers were already on the fire, a D–6 from a nearby gold dredge and an AC tractor from a nearby sawmill. These last two arrived early but were of little use on the original fire.

All effort was now turned toward handling the two fires as one along the following plan: The hand line that had been constructed along the west side of the fire above Bower Cave was to be dropped in to the river to the north and held. The front of the fire on Scott Ridge was to be headed and a line dropped to the river along each flank. The line on the west side was to tie to the hand line at the river. Each of the lines from Scott Ridge was a bulldozer show until they reached the steep river slope. A line was to be built from McCauley's over the ridge to the north and then to the river and tie to the east line from Scott Ridge. The road from the McCauley ranch to Bower Cave was to be backfired. Four of the bulldozers were walked to Scott Ridge where two were to work on each of the lines from Scott Ridge to the river. Two tractors were to operate from McCauley's.

The camp was now in full swing and all incoming men were organized into crews with sufficient Forest Service overhead for good management.

The fire control officer and the forest supervisor came into the camp at about 4 p. m. With the aid of scouting information and aerial photos the final control routes were determined. The fire was divided into four divisions and the division overhead personnel were briefed on the construction and the backfiring plan. By 6 p. m. all crews, tractors, and other equipment were on the line and prepared for a night operation.

The plan went according to schedule and the night work was so efficient that by midnight most of the lines had been built and burned out. Many of the dangerous snags were felled by power-saw crews before the backfires were started. This was an important factor in reducing the possibility of spot fires as well as cutting down mop-up and patrol work later. The fire was declared to be under control by 9 a. m.

A look at the available Forest Service manpower in the early evening indicated that there was not enough for the mop-up job the next day. Needs were calculated and an order was placed for one division team from another forest and 150 off-forest laborers. The division team was flown in from the Sequoia Forest and the 150 laborers were picked up at Stockton in the San Joaquin Valley. All were at camp in time for the next day's shift. The Sequoia team did an excellent job on a division unit and returned to their home forest after one shift.

Mop-up proceeded rapidly during the early morning and the next day with tractors widening lines, with tankers working along the bulldozer lines and the roads, and with power saws felling the remaining snags. Especially important on mop-up was a 4 by 4 blister rust spray rig. This four-wheel-drive unit with its long light hoses reached many places that were inaccessible to the conventional tankers.

Two Pacific marine portable pumpers and hose were taken into the river on the east side of the fire by pack horses and were used very effectively on mop-up on the river slopes. The fire boss was equipped with a jeep and a portable radio during the mop-up period. He was able to cover all of the fire lines in the jeep except the steep river slopes. The fire was declared to be officially out on August 23.

There were many factors working together that contributed to the control of the fire prior to the burning period of the second day. The most outstanding ones are listed in the following paragraphs.

The early and efficient dispatching of personnel and equipment by the district and the central dispatcher was an important factor. Men and materials were ready to go. Sufficient experienced Forest Service and local men were readily available. Exceptionally good cooperation was received from the local people—labor from the sawmills, woods crews with power-felling equipment, electric power line construction employees, and experienced local ranchers. There were 210 men on the line during the night shift and 272 on the line during the next day. Men were released rapidly after the end of the second day's shift.

The effectiveness of the work during the first night was an outstanding factor in the early control of the fire. Control could not have been effected by 9 a. m. the following morning, however, even with the manpower available had it not been for the efficient work of the tractor operators in the heavy manzanita cover. Lights on the six tractors enabled them to work all night. Wide effective lines were the result. Total perimeter of the fire was 598 chains handled as the following tabulation shows:

Type of line:	*Line constructed* (*chains*)	*Line backfired* (*chains*)
Hand	160	50
Tractor	200	200
Road	238	238

Excellent radio communication during the entire fire made administration fairly easy. The radio net centered around the Pilot Peak lookout who used a T set for receiving and relaying messages. Division bosses were equipped with portable SX sets. A mobile unit and then an SX set were used by the fire boss. A mobile set was used in the fire camp.

A telephone connection was made to a nearby line and run to the fire camp. This took a load off the radio net.

The use of aerial scouting and aerial photos for plotting the fire and the control line aided greatly in early control. This combined with limited ground scouting proved very effective.

The camp was well located near the fire and was rapidly put in full operation by experienced personnel. Lunches, lights, water, and other equipment were always ready to go before departure time scheduled for crews. Adequate transportation was available and ably coordinated under the camp boss.

This fire, burning in steep heavily covered terrain, was readily controlled before the second burning period at 1,223 acres because of the effective use of modern fire fighting equipment, the excellent cooperation of local people; and the efficient work of Forest Service personnel.

Fire Camp Food Order.—On large fires, service chiefs, camp bosses, and supply officers transmit long food order messages that tie up telephone lines or radio channels for some time. These food orders often interfere with radio or telephone communication on the fire line that is of first importance. We have devised a method of transmitting food order messages that has proved to be accurate and considerably faster than heretofore.

When the fire boss determines that he will need a fire camp set up our practice is to dispatch a 100-man camp outfit which includes food for 100 men for three meals. From that time on the camp boss orders food according to what he has on hand and what he needs. He uses a food order list on which each food item is given a number. The camp boss lists the quantity of food needed and turns the list over to a telephone or radio operator. The operator transmits the requisition by calling off the item number followed by the quantity desired. Thus there is no need to use the item name. For example: "Fifteen forty" means "forty pounds of sausage." Here two words replace four.

The form is letter size. Its heading and some of the items of food are shown below:

FIRE CAMP GROCERY ORDER

Order received ______ A. M.______ ______________________ Fire Camp
Time out _________________ Received by: ______________________
Truck No. ________________

1. ______ lbs. bacon	80. ______ btls. catsup
2. ______ lbs. butter	89. ______ oz. pepper
15. ______ lbs. sausage	105. ______ ctns. matches
28. ______ boxes apples	114. ______ boxes soda
72. ______ lbs. rice	116. ______ ctns. towels, paper

In addition to the saving in words the list eliminates all writing by the receiving officer except that of merely entering the quantity figure in the appropriate space. This elimination of pencil work speeds up receipt of the message and makes for greater accuracy.

Items 1 through 40 are all fresh or perishable items and are listed together to simplify ordering from merchants or loading from the walk-in refrigerator.

This list also serves the cook and camp boss as a check against overlooking items needed.

A supply of the forms is provided forest officers who may be concerned with ordering food and a quantity is placed in camp boss boxes at the beginning of each fire season.—ALVIN EDWARDS, *Storekeeper, Mendocino National Forest.*

INDEX

April 1946—April 1949

U. S. GOVERNMENT PRINTING OFFICE: 1949

Volume 10 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

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Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1949

Contents

FM RADIO EQUIPMENT FOR FORESTRY APPLICATIONS

W. F. Biggerstaff
Engineer, Forest Service Radio Laboratory, Portland, Oreg.

Present Forest Service frequency modulated radio equipment operates in the 30- to 40-megacycle band. It may be divided into four general types, portable, lookout, mobile, and fixed station. Each of these has a definite use and all are required for a well-balanced network. The number of each type varies, of course, with local requirements. Some of the requirements to be considered are communications on fire lines, communications from fire line to fire camps, communications from fire camps to source of supply, lookout networks where telephone facilities are difficult to maintain, and aircraft activities. It is obvious that no system other than radio will successfully fulfill most of these needs, many of which require equipment of the most portable nature. It was for such reasons that the handy-talkie was given the highest priority on the laboratory development program.

Handy-talkie.—The handy-talkie is the smallest and lightest practical complete radiophone available to date. This general type of set was used extensively by the military forces where extreme portability was a requirement. It is a complete hand-held, self-contained portable radiophone. No accessories or additional equipment is necessary to place it in operation. To simplify operation, the functional controls have been reduced in number to the absolute minimum.

Two specific physical forms are available at the present time. One has the earphone and headphone attached as an integral part of the case and the entire unit is held in the hand for operation; the other employs a standard telephone type handset which is normally carried as part of the handle of the radiophone and detached when used. The antenna in the first unit is telescopic and, when not being used, is carried in clips on the side of the case. The other has a shorter antenna which is bent over and hooked to the opposite end of the case when not in use.

Both have two transmitting channels available, either of which may be selected by the operator. One channel is intended for communication between two similar units, or between a handy-talkie and a mobile set. The other channel is intended for communication with lookouts or with other stations through the medium of the lookout automatic repeater. Both may be used on single-frequency networks, but this arrangement is intended primarily for networks employing automatic repeaters.

Tower set.—The lookout or tower set has been mentioned separately from the other equipment since it has been designed to perform a special function, that of automatic repeating. The lookout or tower set is used primarily to furnish communications for the lookout or towerman and no function has been compromised to secure such service. However, it also provides automatic repeating facilities which are of

extreme value in radio networks employing handy-talkie typ equipment.

The tower set consists physically of a basic unit, a control box, an a power supply. The basic unit contains the radio receiver, transmitters, and control relays, and is connected to the control box or contro boxes by a multiwire remote-control cable. These controls may b located at distances up to 200 feet from the basic unit.

The use of a separate remote-control box, which has a maximun dimension of under 12 inches, permits installation of the basic equipment at any convenient location within 200 feet of the operating position. For example, where space is at a premium, as in a 7- by 7-foo lookout cab, the basic unit may be mounted in a shelter at the base of th tower and only the control box need to be installed in the tower cab Where the towerman lives in a ground house, a second control box ma also be installed in the living quarters. The radio equipment can the be operated from the tower or from the ground.

The power supply consists of dry batteries contained in woode boxes located near the basic unit. Two boxes approximately 26 by 1 by 13 inches hold batteries capable of giving about 30 days' servic when used continuously.

The Forest Service model (type TF) tower set is completely weatherproof, being housed in a cast magnesium case with all connection brought out through pressureproof fittings. It is intended to be lef in place all year. The commercial model is much smaller and sinc all cables may be easily disconnected, it may be removed to a centra shop or warehouse during the "off season." Functional controls ar identical on both makes.

Application of two-channel transmitters.—To illustrate the practical use of two transmitting channels and a single receiving channe on all equipment, and also to illustrate the use of the automatic repeating function on the lookout set, we will use the following example:

A typical Forest network may consist of 4 or 5 radio-equipped lookout towers, 2 or 3 mobile sets, 6 to 10 handy-talkies, and a fixed station The lookout sets will receive on 38 megacycles, which will be called the "Lookout" frequency or "Lookout" channel. The fixed station mobile sets, and handy-talkies will receive on 36 megacycles which will be called the "Portable" frequency. All types of equipment in this hypothetical network will be equipped, by means of dual channel transmitters, to transmit on the "Portable" frequency or the "Lookout" frequency at the option of the operator. We will assume that one of the lookouts spots a suspicious dust cloud or smoke. He selects the "Lookout" transmitting channel and calls another lookout who may see the same smoke. They discuss the possibility of this being a reportable situation and the probable location of the smoke. As soon as a decision is reached, the individual initiating the action may immediately change to the other channel ("Portable") and make his report to the dispatcher at the fixed station. All of this preliminary conversation between the lookouts would not interfere with traffic being carried on between mobile, fixed station, or portable equipment since all such units would be using the "Portable" frequency while the lookouts used the "Lookout" frequency. This, in effect, makes two separate networks with immediate cross-tie available between all types of equipment.

We will assume, as a result of the report, a truck containing a mobile set was dispatched. As long as the truck was in the immediate vicinity of the dispatching station, the truck operator could talk to the station, but such range is usually short. As soon as the truck is far enough to be out of range of the station it must depend upon the lookout to repeat any instructions from the dispatcher. Verbal repeats are not only slow but in many cases result in confusion. It is at this point that the automatic repeating function of the lookout set becomes of value. By a mere flip of the switch the dispatcher may talk directly to the truck operator via the lookout repeater. To secure such operation it is necessary for the dispatcher to change his transmitter switch to the "Lookout" channel and request automatic repeat. He then calls the truck operator who, after switching to "Lookout" frequency, can carry on a two-way conversation with the dispatcher in the same manner as though he were talking directly to the dispatcher station.

After arriving at the fire, the truck and the handy-talkies may be used together without disturbing the lookouts by using the "Portable" frequency. However, the lookouts will be available, if within range, to any of the handy-talkies or the mobile set as soon as they switch to the "Lookout" frequency. In the same manner, any portable or mobile set may be called, if within range, by the lookout changing to "Portable" frequency.

Since only one receiving frequency is involved in any of these various types of equipment, it is impossible for the operator, through inattention or lack of instructions, to be listening on the wrong frequency.

The reliability of a radio network employing such equipment is accordingly increased in a large measure over any arrangement wherein the operator can select more than one receiving frequency.

Mobile.—Since Forest administration and protection requires a great deal of road travel time, mobile equipment is also important in forestry communication networks.

A wide selection of commercial mobile equipment is available for single-channel networks, but relatively few commercial sources can supply dual-channel transmitters without restricted channel spacing. The value of dual-channel mobile transmitting units is being recognized in the industry and more such equipment is becoming available. The application of such equipment was discussed in the preceding section.

Fixed station.—Fixed stations are those more or less permanently installed at any one location. They may be 110-volt powered, dry-battery powered, or they may be powered by some other source of energy such as storage batteries. 110 volts alternating current is to be desired as a power source because of its usual reliability and low operating cost. If power failures are frequent or voltage fluctuations are exceptionally severe, as may be encountered with a small local power plant, a storage battery system may be used. Where alternating current or storage battery power is not available or is not feasible because of installation costs, dry-battery powered equipment must be employed.

In many cases installations at ranger stations and supervisors' offices are at low elevations. This is a definite handicap where VHF is

used because of the limited operating range over low ground. In such cases consideration should be given to possible remote equipment locations on elevated points with remote control over telephone lines. Installing the equipment on an elevated point, within reasonable distance of the station, may result in an additional improvement, namely, getting the receiver out of local electrical noise and interference. Contrary to popular belief, noise does affect FM equipment, although not to the same extent it affects AM equipment.

Future equipment.—An additional equipment type contemplated for early development or commercial procurement is a pack set. This set will have about the same performance characteristics as the lookout or tower set but will be packaged for back-pack transportation.

The unit will incorporate a loudspeaker, have squelch or silent stand-by, and be generally suited for use by work crews who are to be kept "on call" for fire service.

Other applications for the unit will be to furnish temporary or secondary lookout communications, aircraft communications on a temporary installation basis, fire camp communications, temporary mobile service, and fire line communication for sector operations where one man may be assigned to carry the communication unit for one or more crews.

Dual transmitting channel equipment.—The following material catalogs the new series of FM radio equipment designed by the Forest Service or developed commercially especially for dual transmitter channel operations. Since single-channel mobile and station equipment and a limited selection of single-channel portable radiophones are available from a number of commercial sources, only dual transmitting channel equipment is included in this listing.

HANDY-TALKIE TYPE SF, MODEL B–2

(Forest Service)

The type SF, model B–2 handy-talkie is a frequency modulated two-channel transmitter and single-channel receiver designed for voice communication in the 30- to 40-megacycle band. Weight is 9 pounds; size, 4 by 6 by 14 inches high; length of antenna extended, 7 feet; length of flexible counterpoise, 4 feet.

The receiver is a single conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is 60 decibels at 80 kilocycles. The intermediate frequency pass band is 40 kilocycles wide 3 decibels down.

The transmitter is composed of two complete channels employing phase modulation and capable of 15 kilocycles deviation on voice peaks. Power output is approximately 200 milliwatts. The two transmitters are on a separate chassis from the receiver and may be removed independently for servicing.

The range will depend almost entirely upon location. Two or three miles may be expected between similar units over flat terrain, but distances in excess of 50 miles are possible between elevated points such as mountain peaks.

The power supply consists of three standard flashlight cells and two miniature 45-volt "B" batteries. The two "B" batteries are connected

in parallel for the receiver and in series for the transmitter. The change in connections is made by the push-to-talk switch.

Receiver current drain is 400 milliamperes at 1½ volts and 10 milliamperes at 45 volts. Transmit current drain is 400 milliamperes at 1½ volts and 18 milliamperes at 90 volts.

Units produced after January 1949 are equipped with the necessary attachment fittings to permit the use of a separate antenna and special head set and close talking microphone for aircraft application.

Left, handie-talkie type SF, model B–2. Right, handie-talkie type FH2TR–1AL.

HANDY-TALKIE TYPE FH2TR–1AL
(Motorola)

The FH2TR–1AL handy-talkie is a two-channel transmitter and single-channel receiver of commercial design used for voice communication in the 29- to 39-megacycle band. Weight is 11½ pounds; size, 10 inches high by 12⅝ inches long by 3⅛ inches wide.

The receiver is a superheterodyne of cellular construction, each cell being a complete operating stage. Sensitivity is 0.5 microvolt for 20-decibel quieting. Selectivity is such that the attenuation is 40 decibels at 40 kilocycles and 80 decibels at 80 kilocycles. The audio output is 4 milliwatts into a 250-ohm load. Crystal control of the local oscillator is incorporated and the stability is within plus or minus 0.022 percent over a temperature range of −20° to +60° C.

The transmitter is composed of two complete channels which are also of cellular construction. Phase modulation is employed and the output deviation is plus and minus 15 kilocyles. The RF power output is 500 milliwatts. Frequency stability is plus or minus 2 kilocycles over the temperature range of −20° to +60° C.

The operating range between units, using the normal portable antenna, is 1 to 1½ miles over flat terrain. This range increases with elevation of the stations to distances in excess of 50 miles between mountain peaks. All ranges vary depending on local conditions of terrain, surrounding objects, and local noise conditions.

The power supply is composed of 4 standard flashlight cells and 3 miniature 67½-volt "B" batteries. Provision is made for 6 cells if longer life is desired. Battery life is 6 to 10 hours depending on transmitter usage.

Accessories are available for aircraft use and a special antenna is available for semiportable use.

The same unit may be secured with a single-channel transmitter only.

TOWER SET TYPE TF, MODEL A–T2–R

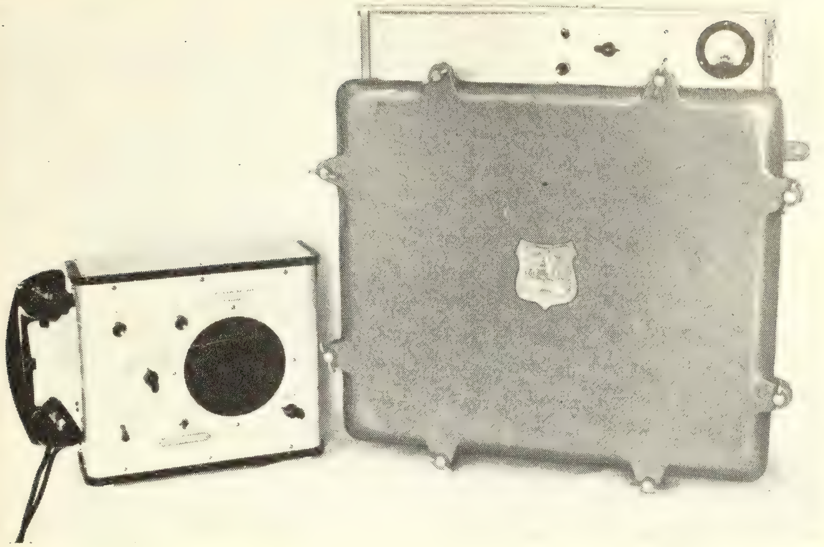
(Forest Service)

The type TF, model A–T2–R, is a frequency modulated two-channel transmitter and single receiver designed for voice communication and automatic repeating in the 30- to 40-megacycle band. It is dry-battery powered and intended primarily for use as a lookout or tower set. The transmitters and receiver are mounted in a weatherproof cast magnesium case and all leads to the control box, batteries, and antennas are brought out through pressureproof fittings. The equipment is operated from a control unit containing the loud-speaker, handset and hang-up box, volume control, and various switches. The control box may be located up to 200 feet from the basic unit.

Weight of basic unit is 51 pounds; weight of control unit, 9 pounds; size of basic unit, 24 inches wide by 23½ inches high by 10 inches deep; size of control box, 16 inches wide by 11 inches by 4½ inches deep, size of battery boxes (2), 26 by 10 by 13 inches high.

The receiver is a single conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is better than 1 microvolt for 20-decibel quieting. The intermediate frequency amplifier band width is 40 kilocycles 3 decibels down. All connections are made to a terminal strip and the receiver may be removed from the case for testing or replacement without disturbing the other equipment.

The transmitter is a conventional frequency modulation transmitter employing balanced phase modulators and capable of 15 kilocycles



Tower set type TF, model A–T2–R.

deviation on voice peaks. Radio frequency power output is approximately 2 watts. The usual arrangement consists of two transmitters (in addition to the receiver and relay controls).

Automatic repeating or local control is secured by operation of a single switch on the control unit.

No definite range can be stated since this is a function of antenna height, location, and other local factors. Distances of 5 or 10 miles may be expected over flat ground with antennas at a height of 10 to 15 feet. Distances of a hundreds miles or more are possible from elevated points or mountain peaks.

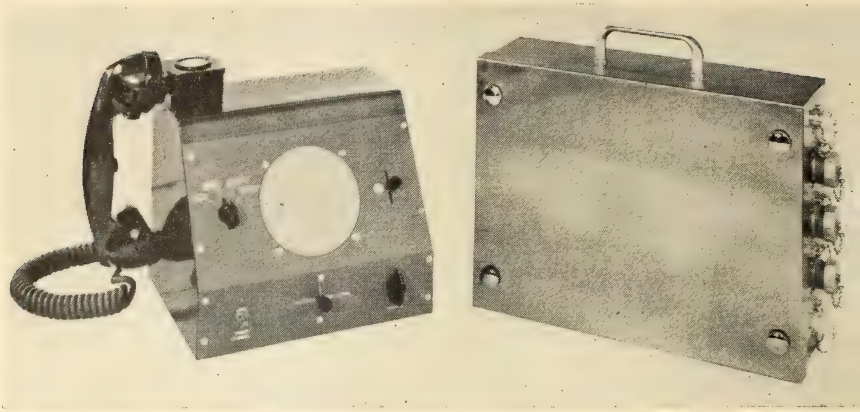
Receiver current drain is 500 milliamperes at 1½ volts and 16 milliamperes at 50 volts with an additional 16 milliamperes at 135 volts when the auto system is used or when the squelch is "open."

The transmitter current drain is 500 milliamperes at 1½ volts and 50 milliamperes at 135 volts.

TOWER SET TYPE FHRT2TR1A1

(Motorola)

The type FHRT2TR1A1 tower set is a complete dry-battery operated radiophone and automatic repeater. The basic unit is housed in a stainless steel case approximately 10½ by 14 by 4 inches and will weigh 15 to 20 pounds less batteries. This set with specially designed boxes for packing two antennas, and the necessary batteries to provide 50 to 100 hours continuous service, will serve as a portable repeater for use on a large fire where repeater service is required and cannot be secured from existing fixed stations. It is of commercial manufacture produced from specifications developed by the Forest Service Radio Laboratory. The set consists of two basic units, a trans-



Tower set type FHRT2TR1A1.

mitter and receiver housed in a small metal case with the associated relays, and a control box containing the handset, speaker, and operating controls. An additional control unit may be connected to provide a second operating position. Power is supplied by dry batteries.

The receiver is a single conversion superheterodyne of cellular construction. Sensitivity is 0.5 microvolt for 20-decibel noise quieting. A squelch circuit is employed that controls the audio output and operates the transmitter control circuit for repeater operation. Selectivity is 40 kilocycles 40 decibels down and 80 kilocycles 80 decibels down. The receiver incorporates a stable crystal-controlled oscillator to furnish the injection voltage.

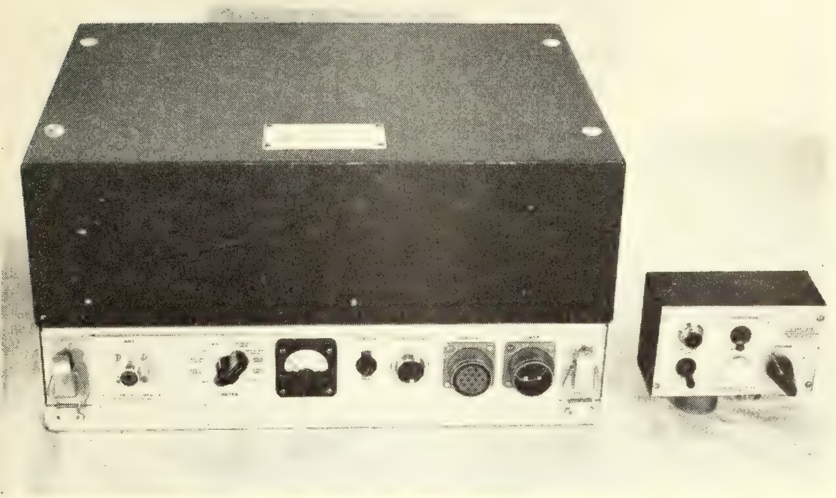
The transmitter consists of two complete channels employing phase modulation capable of 15 kilocycles deviation. Radio frequency power output is 1½ watts. Stability is within plus or minus 0.002 percent from −20° to +60° C.

MOBILE TYPE KF, MODEL A–T2–R

(Forest Service)

The Forest Service type KF, model A–T2–R is a complete mobile FM radiophone designed for operation in the 30- to 40-megacycle band and incorporates a two-channel transmitter and single-channel fixed-frequency receiver. The two-transmitter channels and the receiver with associated power supplies are mounted on one chassis and under one dustproof cover. Such construction makes a very compact unit. Since the receiver is fixed in frequency by a quartz crystal-controlled oscillator, no tuning is necessary by the operator and one major source of failure is avoided. The only controls necessary for operation of the unit are housed in a small box 3 by 4½ by 2 inches that may be conveniently located in the driver's compartment. The controls consist of an ON—OFF switch, speaker volume control, squelch adjustment, and transmitting channel selector switch.

The receiver is a double conversion superheterodyne operating on any predetermined frequency in the 30- to 40-megacycle band. Sensitivity is better than 0.5 microvolt for 20-decibel quieting. Positive noise compensated squelch is incorporated, the threshhold of which is



Mobile type KF, model A–T2–R.

adjustable at the operating position. The intermediate frequency amplifier bandwidth is 30 kilocycles 3 decibels down.

The transmitter is two channel, capable of 25 watts output on any two frequencies in the 30- to 40-megacycle band. Either frequency may be selected from the control box. A crystal-controlled radio frequency voltage is phase modulated and multiplied a total of 32 times to provide output with deviation capabilities of plus or minus 15 kilocycles.

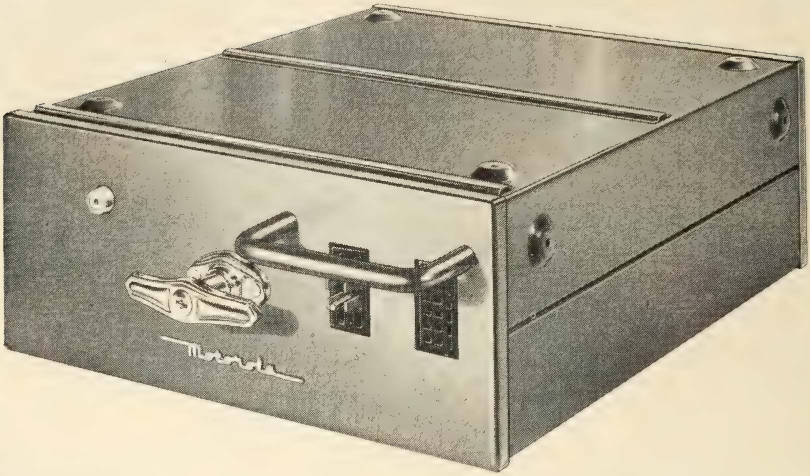
Accessories include speaker, control box, microphone, and cables. Weight is 60 pounds; size, 16½ inches wide by 8½ inches high by 15 inches deep; stand-by current drain, 12 amperes; transmit current drain, 22 amperes.

The range will vary considerably, depending upon the location of the two stations and the terrain over which communication is carried. It will vary from a few miles for two similar units communicating over flat ground to 50 miles or better from elevated points.

MOBILE TYPE FM2TR8OD(B)1SP1

(Motorola)

The type FM2TR8OD(B)1SP1 is a mobile radiophone of commercial design manufactured to operate in the 30- to 40-megacycle band. It incorporates a two-channel transmitter and a single-channel receiver designed for voice frequencies. Size is 6⅛ inches high by 21 inches wide by 20¼ inches long; stand-by current drain, 10 amperes; transmit current drain, 47 amperes.



Mobile type FM2TR8OD(B)1SP1.

The receiver is a superheterodyne having a sensitivity of 0.4 microvolt or less than 20-decibel quieting. Receiver-injection voltage is provided by a stable crystal-controlled local oscillator. Alternate channel selectivity is 85 decibels or better at 80 kilocycles.

The transmitter is composed of two separate channels capable of operating on any predetermined frequency in the 30- to 40-megacycle band. Phase modulation is employed and the deviation capability is 15 kilocycles. Instantaneous deviation control is incorporated in the modulator section. The radio frequency power output is 30 watts.

MOBILE TYPE 2164
(Link)

Transmitter mobile type 2164 is 8 inches by 10 inches by 12½ inches. Weight is 30 pounds; power output, 25 watts either channel. Receiver separate, same size as transmitter. Total stand-by current drain is 5¾ amperes; transmitter current drain, 23 amperes.

REGION 1 STRETCHER CARRIER PROVED IN AIR RESCUE OPERATION

H. K. Harris

Forester, Region 1, U. S. Forest Service

The latest model of the modified Stokes litter with wheel attachment, known as the stretcher carrier, developed for use of the Region 1 air rescue squad and described and illustrated in Fire Control Notes,[1] received its first real test last fall. It was used in the evacuation of a hunter who had been lost in the remote Selway River area of Idaho. When found, the hunter was so weakened by exposure and starvation that it was necessary to move him to a hospital as quickly as possible.

William C. Wood, parachute project foreman in charge of the air rescue squad reports the action. Excerpts from his interesting report follow:

On October 11, 1948, at 11 : 30 p. m., I was notified of a call to assist in the search of a lost hunter in the vicinity of Pettibone Creek on the Selway River. Because of the late hour and short notice, I was able to contact only eight men willing to go on the mission. Upon arriving at the parachute loft the next morning, I was informed that four additional men were available. Also available was Parachute Foreman Albert W. Cramer, who was to assist me in organization.

Flying in a C–47, we arrived over the jump spot at 10 : 30 a. m. and were on the ground with full equipment at 11 : 30 a. m. After a light lunch, the 10 men were lined out 20 to 30 feet apart between Cramer and myself. We contoured across the search area with Cramer blazing a line to the boundary of our area. We returned in the same manner except that Cramer followed his blaze back and I put in a new blaze line at the lower edge of the strip. This procedure was closely followed in our 2½ days of search.

Fortunately the lost hunter, a man 65 years old, was found Thursday night, October 14, 1948, by Ranger Jack Parsell and Alternate Side Poppe. He had been without food for 7 days.

Parsell was searching the creek bottom for tracks and Poppe was paralleling the creek at distances from 50 to 100 feet, when Parsell noticed a jumper streamer hanging in a bush. Three of our jumpers had left the orange signal streamer to facilitate finding their jump spot when they returned to retrieve their chutes. Parsell yelled "Hey, Sid, here's a jumper signal!" Immediately following Parsell's exclamation, Poppe heard a weak cry, "Hey!" Upon investigating, he discovered the lost hunter leaning against a tree about 20 feet from the edge of the creek, directly opposite the jumper streamer.

They covered the patient with their jackets and, while Parsell went for help, Poppe kindled a fire. Parsell reached camp at 5 : 30 p. m., just as our crew came in for supper. We immediately gathered a kapok bag, a cargo manta, and about 30 feet of cargo chute line for improvising a stretcher. A canteen of hot coffee and another of hot sugar water, an ax, and all available flashlights were also taken.

We reached the patient at 6 : 30 p. m. Exposure and starvation had weakened him considerably and because of violent trembling it was necessary to assist him in taking hot stimulants. While constructing the stretcher and administering first aid, I asked the patient if he had seen the orange jumper signal, and he

[1] H. K. Harris. Stretcher carrier. U. S. Forest Serv. Fire Control Notes 10 (1): 10–11, illus. 1949.

replied "Oh, is that what that was? I knew it didn't belong there, but I couldn't get over there to find out, so I just stayed here." Undoubtedly, the orange streamer played an important role in saving the man's life.

With the lost man on the pole and canvas litter, we reached the search camp at 8 p. m. A good thick mattress of pine boughs with a kapok bed made him quite comfortable. Canteens, improvised as hot-water bottles, were added to keep him warm. The patient's physician was contacted by radio at 9:30 p. m. and we were instructed to evacuate the patient as soon as possible. The modified Stoke's litter and wheel attachment were ordered for delivery by plane. The following morning, October 15, at 8:30 a. m., the stretcher and wheel were dropped.

By 9:30 a. m. camp was broken and the stretcher crew started out. One man guided the crew through logged-up sections of trail. It was soon learned that detouring for windfalls less than 4 feet high resulted in slowing the rate of progress. The best method was to have the guide limb the windfalls to the width of the trail, and the crew, upon encountering them, would lift the wheel stretcher over. Windfalls having a vertical clearance of at least 4 feet were limbed on the underneath side and the litter was wheeled under them. It was important to have the guide working well in advance of the crew to prevent the litter from being held up while clearing was accomplished.

Pettibone Creek was forded twice by merely adding extra men to the sides of the stretcher and sloshing through the shallowest portion of the ford.

On a good trail, level, or downhill grades, it was possible for two men to pull the stretcher at a fast dog-trot. Uphill grades were more tiring, but a good rate of speed was maintained by adding side men to assist the main bearers.

At least six stops were made on the trail to administer water and hot stimulants to the patient. Twenty minutes were spent feeding the patient at the Selway River.

We arrived at Shearer landing field, at 2 p. m. (It was estimated that it would require approximately 8 hours to evacuate the patient.) We had moved the patient from the Deep Saddle Trail on Pettibone Creek to Shearer landing field, a distance of 14 miles, 6 of which were badly logged-up, steep, and not maintained, in 4½ hours. With a conservative estimate of 1 hour spent in attending the patient, I believe we are justified in claiming the fastest evacuation of a litter patient ever effected in the mountainous terrain of Region 1.

We may have been in error in reporting that the Stokes litter was developed by the Army. It is used by both Army and Navy. Modifications for use on narrow, rocky trails, and transporting persons down steep slopes, over windfalls and through brush and timber was necessary to make it most effective for our work. This was a Forest Service development. Collapsible handles facilitate airplane transportation, and light tubing along each side strengthen the stretcher. The carrier wheel is detachable and may or may not be used, depending upon ground conditions. The unit is accordingly packed for dropping in two separate packages. There is little question but that speed and ease of operation is increased by the use of the wheel in open areas or along trails. (Detailed descriptions of all equipment, organization, and training of the Region 1 air rescue squad is being prepared as a chapter of the new Air Operations Handbook.)

DUAL PURPOSE FIRE EQUIPMENT BOXES

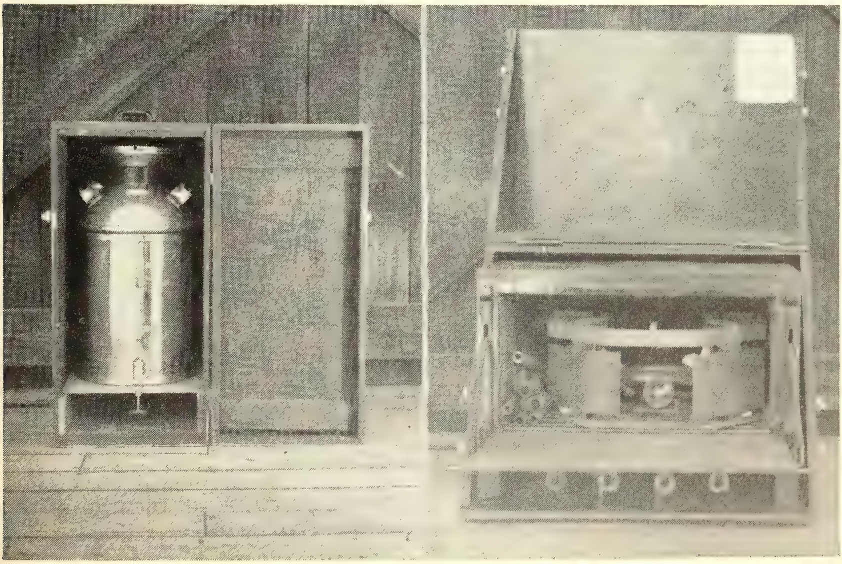
Alvin Edwards

Storekeeper, Mendocino National Forest

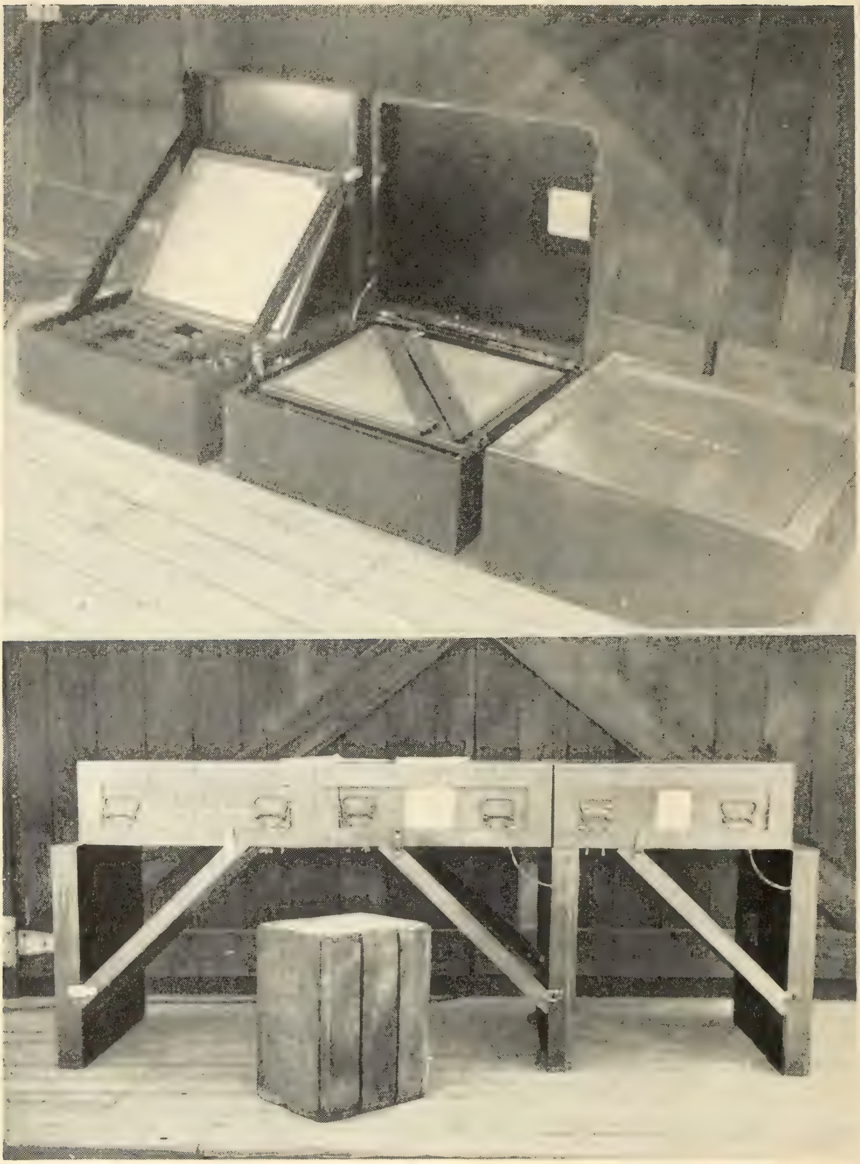
Some of the specialized fire camp equipment was difficult to transport without the possibility of damage or the scattering of some of the pieces. To prevent damage and to assemble complete outfits in containers special boxes were prepared. These boxes were also designed to serve a useful purpose in the fire camp. They were used during 1948 and found satisfactory for the purposes intended.

Hot or cold drink dispenser.—A self-closing spigot, sometimes called a restaurant water dispenser, was fitted to the bottom of a 10-gallon milk can and a box constructed to prevent breakage in transit. The dispenser sits securely on top of the box in the fire camp. The men can serve themselves by merely pushing their cups against the self-closing spigot.

Fire camp stove oven.—The box built for the fire camp stove oven also contains the hot-water stove, oven legs, and regulator. It was designed to serve as a radio desk in the fire camp. For that reason 1-inch pipe flanges were mounted to the bottom of the box on each corner so that 1-inch pipe legs could be quickly attached. The lid of the box can serve as a sunshade for the radio operator by being tilted forward and held in position by cord or chain between the two handles on one side near the top of the box.



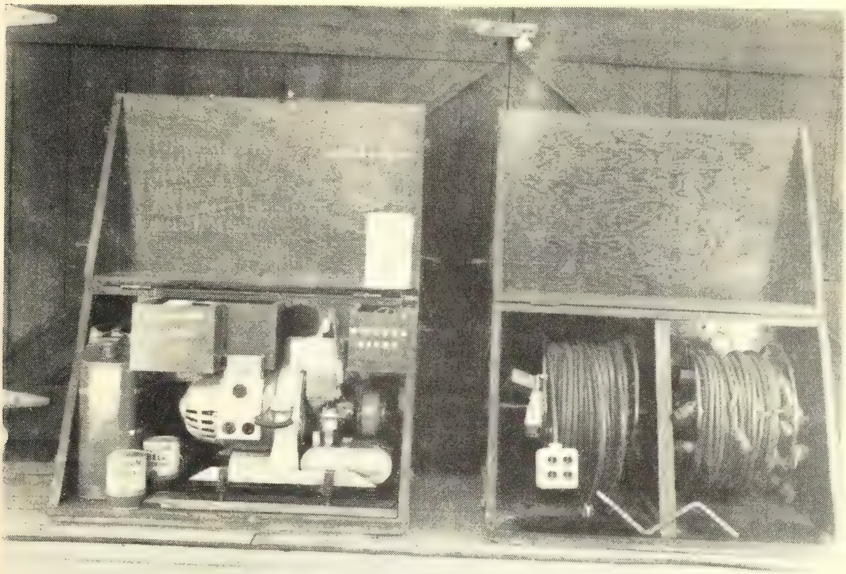
Left, drink dispenser with self-closing spigot. *Right,* fire camp stove oven with oven door open to show hot-water stove and box legs.



Upper, fire camp stove boxes with braces in place, braces detached, and top down. *Lower*, the three boxes set up as a table.

Fire camp stoves.—Boxes were built for fire camp stoves and contain the stove burners, stove grill, a solid grill plate with grease troughs, and stove legs. By the use of special braces and short supports fastened with wing nuts two of the boxes can be converted into a table that may be used for any purpose needed in the fire camp. The third box increases the length of the table.

Portable generator and accessories.—Two boxes were designed to contain the portable generator and lighting cable. The one with the generator also carries fuel, grease, light bulbs, and servicing tools. The two cable reels in the other can be operated individually with the hand crank.



Left, generator with fuel, oil, bulbs, and tools. *Right*, lighting cable.

Fire Suppression at a "Profit" in Delaware.—For 1948, a number of States are able to boast of a good fire record because of the lowest number of fires, smallest average-size fire, lowest number or lowest percent of protected acres burned for any year since the beginning of organized fire protection. To this, State Forester Bill Taber of Delaware has added one more record which is doing a fire fighting job at an apparent profit.

This unusual situation was brought to light when State Forester Taber submitted his 1948 annual fire report. The report had not been completed because fire suppression costs showed a minus quantity. In other words, collection of suppression costs from individuals responsible for fires had exceeded actual 1948 suppression costs. This, of course, included fires occurring prior to 1948, but whose suppression collections were made in 1948. Bill apparently wasn't sure how to show the distribution of a minus quantity on the form and frankly, since it was something out of the usual, some thinking was done in the regional office before final action was taken.

Delaware has enjoyed a good fire record for a number of years. In these same years, Delaware's law enforcement record has shown a percent of convictions running from 76 to 100. Making it unprofitable to start a fire is one of the reasons behind Delaware's showing a "profit" in fire suppression.—Ephe M. Olliver, *Region 7, U. S. Forest Service.*

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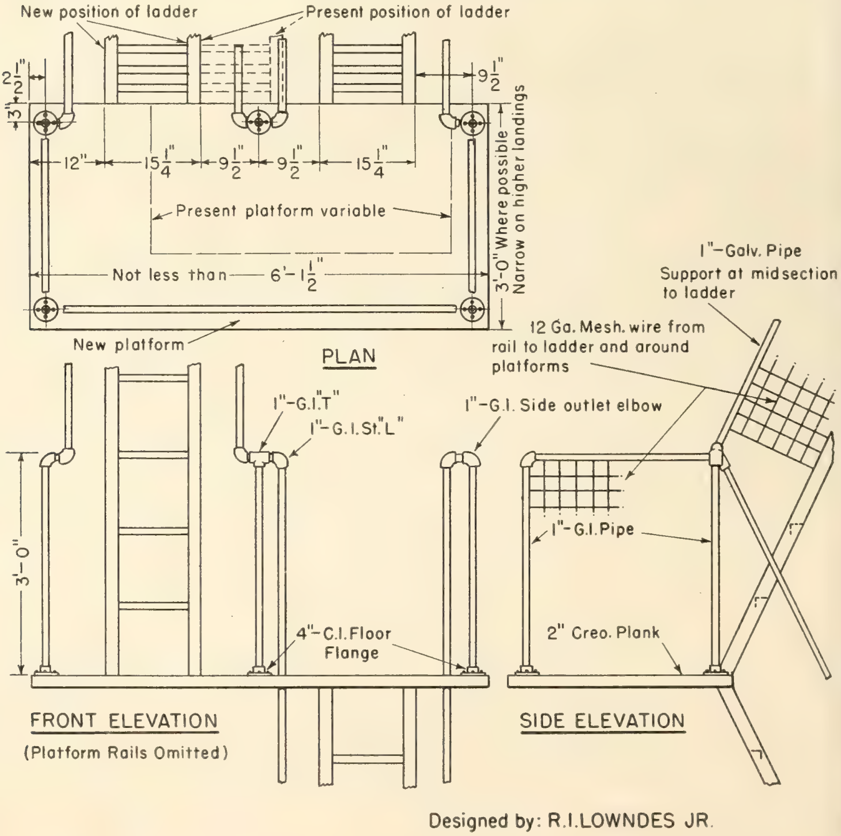
SAFETY LADDER FOR AN INSIDE LADDER TYPE TOWER

R. I. LOWNDES, JR.

Forest Engineer, Cherokee National Forest

The usual inside ladder type tower is probably one of the most difficult to climb, especially if tools, equipment, or other objects burden the climber. Certainly it is most dangerous, because of the very narrow, steep ladders and the narrow short platforms.

Towers of this type do not, ordinarily, possess sufficient strength in their structural design to carry the added weight and resistance to wind that replacement of the ladder by a stair would inflict on it. Also, the narrowness of the ladders, plus their closeness entering and leaving each platform, does not allow sufficient space to add handrails or similar supporting structure to be used as a frame for wire mesh.



The platforms can be enlarged without changing the supporting members by overhanging the platform boards. A few additional anchor bolt holes will have to be drilled through the supporting members. The ladders can be separated one additional ladder width by using the present outside ladder stringer anchor bolt holes for inside ladder stringer anchor bolt holes at the bottom and top of alternate ladders.

One-inch galvanized iron pipe is amply strong for all railings and posts, and these will not endanger the stability of the tower by their added weight or wind resistance. This device (see drawing for details) is easily fabricated and installed by anyone with a knowledge of pipe fitting.

"Watermelon" Hose Roll.—Gathering up wet linen hose after use on a fire is one of the problems in forest fire fighting. Much of the new linen hose and particularly the treated forestry hose becomes unwieldy and difficult to manage. A small quantity may quickly fill a stake body truck before the job is barely begun.

At the Northeastern States forest fire equipment meeting in New Jersey in 1947, the Connecticut foresters put on a demonstration of rolling up wet hose.

A roll of hose takes shape.

The demonstration created sufficient interest to have it repeated again at the Fryeburg, Maine, equipment meeting in 1948. For those interested but unable to attend either meeting and because of the very limited distribution of the 1947 and 1948 reports, the following steps have been taken from the reports:

1. Wet hose is gathered up a length at a time by using a stick, piece of board, or straight pole 2 or 3 feet in length as a core.
2. After one complete wind of hose has been made, the core is turned at a 90° angle before making the next lap.
3. Turning and winding are repeated until the entire length is rolled.
4. The loose end is given a half hitch and the coupling is tucked under to prevent unwinding. After some practice, no rigid core or stick is necessary in making a neat pack job.—Edward Ritter, *Forester, Region 7, U. S. Forest Service.*

SAFE CARGO DROPPING

Lawrence J. Sohler

Airplane Pilot, Region 6, U. S. Forest Service

The following is an attempt to bring out some of the important points in connection with cargo dropping, such as air speed, air resistance, force of gravity, airplane angle-of-attack.

When an airplane is flying at a reduced speed, the anchor fittings for the tail brace wires or struts may be about the same level as the cabin floor at the door. Since many types of airplanes are used for cargo dropping, some will even have these fittings below the floor level at reduced speed. These present the more critical arrangement. Airplanes, which have a high cruising speed or a comparatively low location of the horizontal tail surfaces, associated fittings, and brace wires or struts, may inherently present extra hazards for cargo dropping.

Force of gravity.—Any object regardless of size, shape, or weight will fall the same amount in a given length of time except as retarded by air resistance. For our purpose, air resistance which will reduce the rate of fall will not have to be considered because we are not concerned with the rate of fall for longer than 1½ seconds after the packages are released. One second after packages are released they will be falling at 32 feet per second or about 22 miles per hour. This speed is not enough to cause air resistance that will vary the rate of fall appreciably on any airplane cargo to be considered here.

At a rate of 90 miles per hour or 132 feet per second, an airplane will travel 8¼ feet in one-sixteenth of a second. That is the time it will take for the tail of some airplanes to get to the same place in space where the door was. An object will fall only ¾ inch in that length of time. Why, then, do not many packages strike the tail brace wires?

There are two reasons. One is because the packages are some distance from the side of the fuselage when the tail passes over them. Because of the angle at which the tail brace wires attach to the fuselage, the farther away from the fuselage the packages are when the tail passes over them, the better the clearance will be. The other and principal reason is the packages travel forward some in the direction the airplane is traveling, because of their momentum before the air resistance slows them down. The rate at which this forward travel is reduced depends upon the weight, shape, and size of the package. A light bulky package will travel forward only a short distance, and therefore, will be passed by the airplane tail before it has much time to drop.

When cargo is only just pushed out of the door of an airplane, the elapsed time until the tail passes over it is the only figure needed to determine how far the package will be below the tail surfaces and

brace wires. One package can be considered to fall just as fast as another during the first second for our purpose. We assume no packages will be discharged which are so shaped that they will present a lifting surface and create any appreciable amount of lift due to the relative air speed.

We know that at 90 miles per hour it will require one-sixteenth of a second for the tail to pass the point in space where the door was when the cargo was pushed out. If a very light package is discharged, it will not travel forward far because of air resistance. A heavy package will overcome the air resistance and travel forward some. Because of this forward travel, the elapsed time will be greater before the tail passes over the package, and it is only this additional length of time that will cause it to be farther below the tail surfaces. If this amounts to one-half second, the tail will pass 4 feet over it; in 1 second it will be 16 feet above it, etc.

Attitude or position of airplanes in dropping.—Air speed should be decreased during the dropping operation to reduce the parachute opening shock and minimize the probability of tearing the parachute from the cargo package. Air resistance increases at the square of the air speed, and at 100 miles per hour it is twice as much as at 70 miles per hour. Since the air resistance is less at reduced speed, packages will travel forward farther relatively after being pushed out, and the elapsed time until the tail passes over them will be greater. However, by reducing the air speed the tail is lowered to increase the angle-of-attack to maintain level flight. Reducing the air speed on a fast airplane to 80 miles per hour will not make it as desirable for cargo dropping as one that normally flies at that speed. The tail will be kept lower and the packages will have farther to drop to clear it.

Difference in airplanes.—An appreciable difference between makes of airplanes will be found in the level of the cabin floor at the door and the horizontal stabilizers and their bracing wires or struts. Because a package or parachute may clear safely on one airplane does not hold that it will on another make. Airplanes having a high wing loading will of necessity have to be flown at a greater angle to maintain level flight at a given air speed.

Safety measures.—When packages are discharged they must be put out as low as possible and should be given a start in a downward direction. Packages must be prepared for dropping so that they will offer as little resistance as possible to insure at least a certain amount of forward travel after being discharged.

The above information indicates the necessity of being careful that no parachute ever gets out ahead of the cargo. Very light packages are dangerous and should not be dropped except when proper methods are employed. Packages that offer a wide flat surface may cause serious trouble if they are not properly discharged because the reaction of the air may cause them to rise rather than fall immediately after being discharged. One safety measure has been to modify the Region 5 Noorduyn and the three Region 6 Noorduyns to permit discharging the cargo through an opening in the floor in the rear section of the cabin. The intended purpose of this hatch is to obtain maximum clearance of the tail surfaces and brace wires with all cargo and parachutes being discharged. The seriousness of the cargo dropper's work should be given ample consideration by everyone connected with cargo dropping.

MISSOURI CONSTRUCTS WOOD TOWERS

George O. White

State Forester, Missouri Conservation Commission

In the early days of fire control work before the modern steel structures came into being, a considerable amount of ingenuity must have been demonstrated by Federal and State Foresters in constructing lookout towers. We learned this because the program of the Division of Forestry of the Missouri Conservation Commission, which started in 1938, was just nicely underway when steel was given a high priority for defense purposes and became practically unobtainable.

Constructing foundation for 60-foot wooden tower.

In addition to our inability to secure steel towers, our program operated on a very small budget and so we would hardly have been able to purchase modern towers even if they had been available. It is probable that most of the early wooden towers were made without detailed plans; at least none could be found to serve as guides for a struggling young forestry program.

Our district foresters used imagination in setting up temporary structures, most of which were very crude but served, temporarily at least, to find more fires than we could control. Now, by a process of evolution, we have developed a wooden tower which is quite satisfactory to our needs. It has enabled us to build up a good system of lookout towers, which we could not have done had we been forced to wait for steel and the funds to procure it.

At most of the State tower sites in Missouri, a 60-foot tower gives quite satisfactory coverage and the standard we have developed covers this height. Four poles of creosoted southern yellow pine, 60 feet in length, provide the legs; the stairway and braces are of untreated

rough oak; and the cab is of finished lumber. The tower is designed to use braces and timbers, other than the legs, of not more than 16 feet in length so that native Missouri timber can be used. It is difficult to find portable mills cutting longer lengths here. We feel that the construction of this type of tower has resulted in a considerable saving and has made possible facilities that could not have otherwise been provided.

We have kept a careful record of expenditures on a number of these towers and although there is some variation in their costs, an average is about as follows:

Material	$1,000
Specially employed labor	850
Regular Commission employees (contributed time)	290
Use of Commission equipment	60
Total cost	2,200

Those of you who have constructed steel towers recently will be able to compare the cost with these wooden towers. It is understood that the steel alone in a 68-foot tower might cost close to $3,000 at present prices, not counting the cost of the foundation, plus labor of construction.

Of 51 towers operated by the Missouri Conservation Commission, 30 are wooden towers of approximately the same design as shown in the photographs.

Left, erecting fourth pole. Note the A-frame used to raise pole. Poles are prepared for braces prior to elevating them into position. Right, completed tower with exception of radio antenna and flagpole.

VEHICLE BRAKE TESTER

Arcadia Equipment Development Center

Region 5, U. S. Forest Service

The instrument described in this article has proved to be very useful in determining the adequacy of brakes on various loaded fire vehicles, and in training and testing vehicle drivers.—*Ed.*

The standard AAA brake tester has been a necessary piece of equipment for use in the Region 5 driver-training program, as well as for vehicle testing by the Arcadia Equipment Development Center. The double-barreled electrical detonating brake tester, which is a patented article, was obtained from the AAA at a cost of approximately $17. This unit allows driver reaction and vehicle braking distances to be measured separately.

The electrical detonating brake tester consists of the four units, brake-pedal switch, stopping-signal switch, interconnecting wiring, and detonator unit (fig. 1).

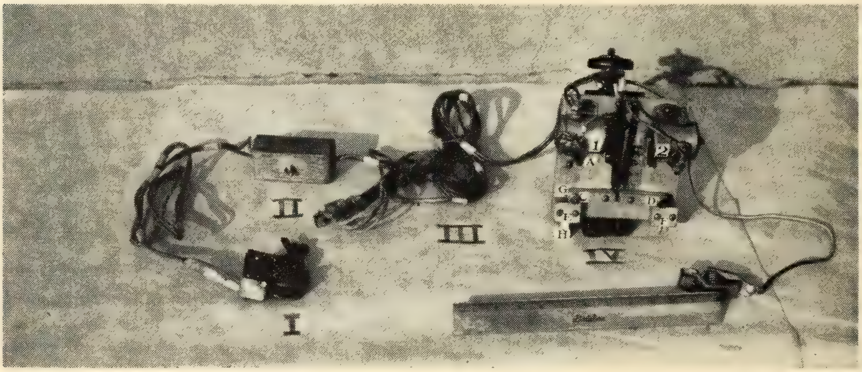


Figure 1.—AAA electrical detonator brake tester as modified by U. S. Forest Service: I, brake-pedal switch; II, stopping-signal switch; III, interconnecting wiring; IV, detonator unit.

As originally received, the AAA brake-testing unit had a strap attached at the top so that it could be hung over the running board by laying the strap on the floor of the car and then closing the door. For late-model passenger cars this method was satisfactory, but for the varying types of trucks, passenger cars, and other equipment to be checked, a different mount was needed. A clamp was designed for mounting the detonator on any type of bumper, running board, or other convenient part of the vehicle (fig. 2).

The detonator unit itself (fig. 3) consists of two magnetic switches (solenoids), two triggers, two hammers, and two blocks or barrels, each of which holds a blank cartridge and a piece of chalk.

Figure 3 shows the right hammer D having been fired, while left hammer C is ready to fire. Electric magnet 1 holds trigger A in a vertical position, which in turn holds spring-actuated hammer C in a cocked position. When the circuit is broken, hammer C strikes blank cartridge G, which expels chalk H onto the road surface, making a white mark.

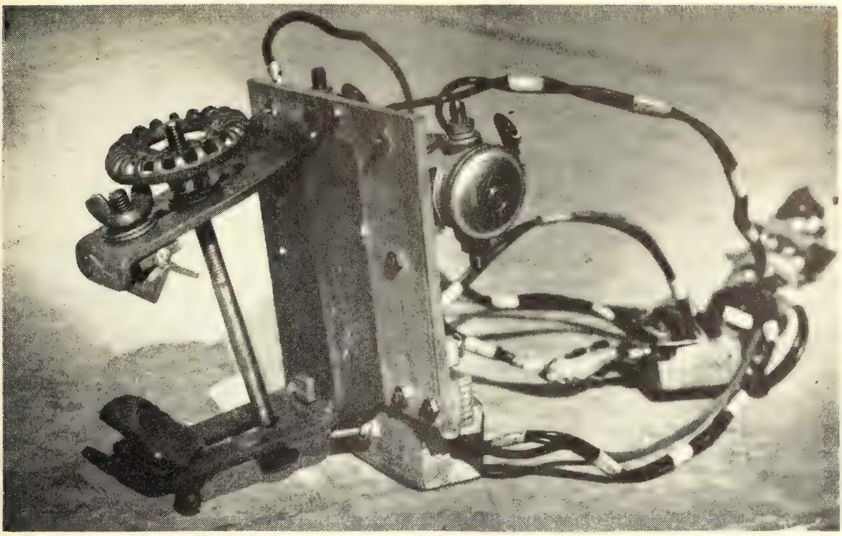


FIGURE 2.—Universal clamp mounting for brake tester.

As originally supplied, a mercury switch mounted in a small block of wood was attached to the brake pedal by means of a flat steel plate that went over the top of the brake pedal and two spring prongs that slipped under the pedal face. Since this system of mounting did not

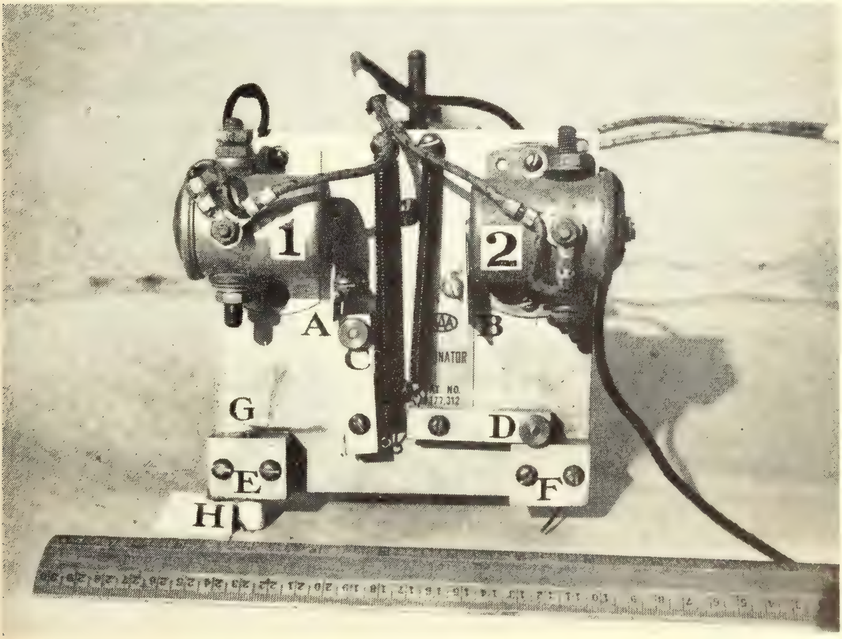


FIGURE 3.—Detonator unit of AAA brake tester: 1 and 2, Magnetic switches; A and B, triggers; C and D, hammers; E and F, blocks or barrels, each of which holds a blank cartridge (G) and a piece of chalk (H).

fit all the types of equipment that were to be tested, the switch was mounted on a small "C" clamp. This allowed for a more secure mounting of the switch on the shank of the brake pedal of all vehicle makes and models. In operation, the function of this mercury switch is to break the electrical circuit to the second magnetic switch, and thus place a mark on the pavement at the instant the brake is applied by the operator.

Originally, the stopping-signal switch controlled only the current to the first solenoid. Under this condition, once the detonator was set, it was imperative that the brake pedal *not* be touched by the operator until the test was under way. Otherwise, the misfire of No. 2 marker would void the particular test. To obviate this difficulty, the wiring was revised as shown in figure 4.

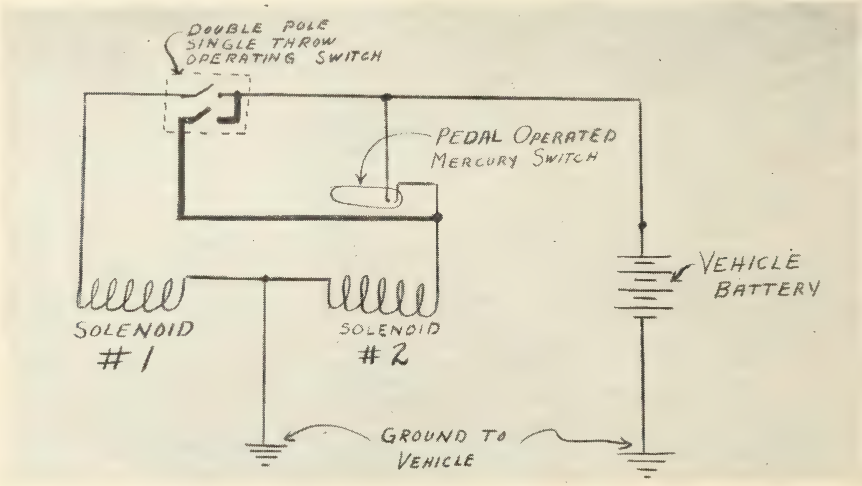


FIGURE 4.—Revised wiring diagram of AAA brake tester. Extra heavy lines denote the added wiring and switch pole that acts as a shunt around the pedal-operated switch until the stopping-signal switch fires number 1 solenoid and energizes the pedal mercury switch.

Wiring of the unit was increased in length for more convenient mounting of the equipment (fig. 5). The ground side of the solenoid connects through the ground wire and spring clip to any convenient grounded point on the frame of the vehicle. The hot wire is of sufficient length so that its spring clip can be connected either to the battery direct or to a "hot" terminal under the instrument board.

In operation, the unit works as follows: After the detonator is mounted, loaded, and set, the driver is instructed to drive along the level testing route at a stated speed. He is further instructed that as soon as he hears the blank cartridge fired he is to stop the vehicle immediately. When the vehicle comes to a full stop, he must hold it at that point and not allow it to roll forward or backward.

The test proceeds as follows: When the desired speed has been attained, the stopping-signal switch is thrown by the examiner, unknown to the driver. This fires the first blank cartridge, which signals driver to stop, and places a chalk mark on the road surface (*A* in

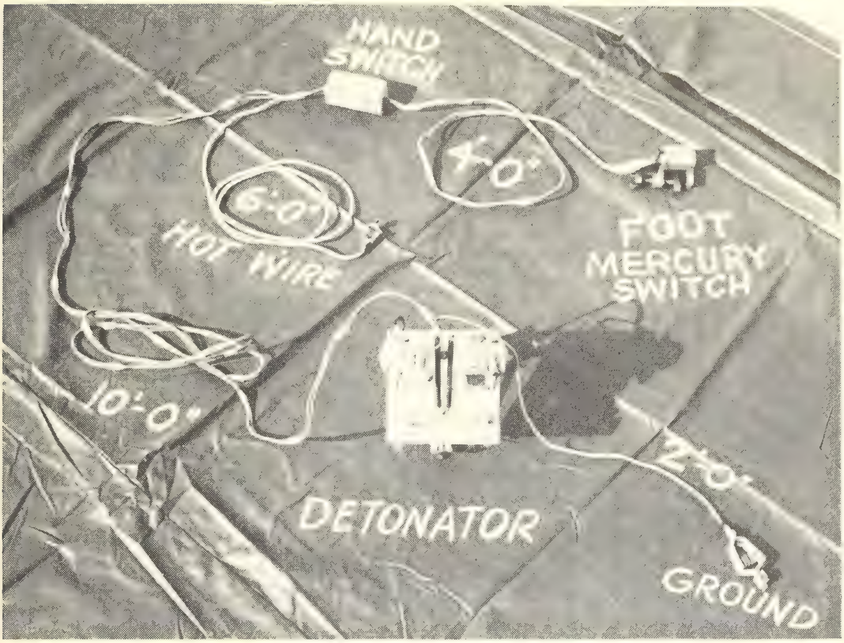


FIGURE 5.—Arrangement and length of wires.

fig. 6). As soon as the driver touches the brake pedal, the second cartridge fires and places the second chalk mark (B) on the road surface. When the vehicle is stopped, a chalk mark (C) is placed by hand directly under the position of the detonator unit. The reaction distance of the driver is measured between the chalk marks A and B.

FIGURE 6.—Markings on pavement as made by AAA detonating type brake tester.

The braking distance of the vehicle is measured from chalk mark *B* to chalk mark *C*. Figure 6 shows one driver's marks for 10 miles per hour with the detonator mounted on the vehicle running board.

The following tables, taken from the AAA instruction manual, make it possible to convert the distances for 20, 30, or 40 miles per hour to reaction time in seconds and braking efficiency in percent.

TABLE 1.—*Reaction distance for three speeds by reaction time*

Reaction time (seconds)	Distance between chalk marks *A* and *B*, fig. 6, for speeds of—		
	20 miles per hour	30 miles per hour	40 miles per hour
	Feet	*Feet*	*Feet*
0. 1	2. 9	4. 4	5. 9
. 2	5. 9	8. 8	11. 7
. 3	8. 8	13. 2	17. 6
. 4	11. 7	17. 6	23. 5
. 5	14. 7	22. 0	29. 4
. 6	17. 6	26. 4	35. 2
[1]. 7	20. 5	30. 8	41. 1
[1]. 8	23. 5	35. 2	46. 9
. 9	26. 4	39. 6	52. 8
1. 0	29. 3	44. 0	58. 7
1. 1	32. 3	48. 4	64. 5
1. 2	35. 2	52. 8	70. 4
1. 3	38. 1	57. 2	76. 2
1. 4	41. 1	61. 6	82. 1
1. 5	44. 0	66. 0	88. 0

[1] Reaction time of average driver is 0.75 second.

TABLE 2.—*Braking distance for three speeds by braking efficiency percent*

Braking efficiency (percent)	Distance from chalk mark *B* to location of detonator, chalk mark *C*, fig. 6, for speeds of—		
	20 miles per hour	30 miles per hour	40 miles per hour
	Feet	*Feet*	*Feet*
10	133. 6	300. 6	534. 4
20	66. 8	150. 3	267. 2
30	44. 5	100. 2	178. 1
40	33. 4	75. 2	133. 6
[1] 50	26. 7	60. 1	106. 9
60	22. 3	50. 1	89. 1
70	19. 1	42. 9	76. 3
80	16. 7	37. 6	66. 8
90	14. 8	33. 4	59. 4
100	13. 4	30. 1	53. 4

[1] Minimum braking efficiency as allowed by Forest Service Safety Code, 1948, is approximately 50 percent.

This brake tester is an efficient and accurate unit in determining the braking performance of any motor vehicle, as well as definitely ascertaining the distance traveled during reaction time. It is recom-

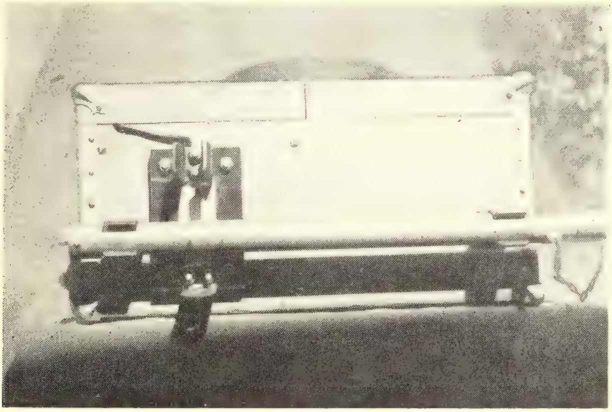
mended that this instrument be used as a regular part of any driver-training or equipment-testing program.

[Federal Government or Cooperative Forest Protection agencies interested in securing this brake tester with the necessary revisions, may purchase the original unit (approximately $17) from Traffic Engineering and Safety Department, American Automobile Association, Washington, D. C., and send it to Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Drive, Arcadia, Calif., for alteration (approximate cost $8); or write for further detailed modification instructions.]

Type SX Radiophone Antenna.—Region 5 found the antenna set-up illustrated has increased usefulness of the type SX radiophone set manyfold, especially in fire line work where time and suitable antenna supports are at a premium.

The antenna proper is a war surplus item identified as a type AN–29–C telescopic antenna. It is approximately 13 feet long fully extended. The mounting and upright holding clips are salvaged pump holder clips from back-pack pumps.

The upright holding clips are mounted on a piece of canvas base Micarta insulating material ½ by 2½ by 4½ inches. One clip is mounted toward the top of the block and is electrically connected to the "ANT" post of the SX set. A



Antenna in carrying position.

bottom angle bracket is mounted on the lower side of the block. This lower angle bracket is made by sawing off one lip of a clip, the remaining lip being hammered straight and a ¼-inch hole drilled in it to accommodate the screw mounting stud on the bottom of the antenna proper.

The top clip and the bottom angle support are held on the Micarta block by ¾″ x 10–32 flat head countersunk machine screws. The block is fastened to the wood box by four 1″ x 10–32 truss head machine screws. The two end clips are mounted on the wood box with ½″ x 10–32 truss head machine screws. A suitable small metal reinforcing plate is also installed on the inside of the box opposite each clip.

Technical adjustment of the antenna loading capacitor within the set proper must be made before putting the antenna into operation.

There are slight electrical deficiencies as a result of mounting the antenna rod as shown; however, this is more than overcome by providing complete portability thus permitting the operator to quickly change locations.—Guy V. Wood, *Communications Engineer;* D. A. Galbraith, *Angeles Radio Technician;* and A. H. Schoss, *Stanislaus Radio Technician; Region 5, U. S. Forest Service.*

WE COMBAT FIRE THE COOPERATIVE WAY

J. Whitney Floyd

Chief Forester-Fire Warden, Utah

We've got a habit of long standing in the West. We cooperate. The custom probably grew out of the early experiences of the western pioneers. They had to get together and work together. Otherwise they stood to lose; livestock, household goods, or a scalp. Thus it was second nature for the third and fourth generation of westerners to cooperate in combating fire. Apparently there has always been cooperative action on fires in the State of Utah. But the action was most generally taken as a measure of self- or property-protection until organized fire protection became widespread.

The first opportunity for organized participation came when the Forest Fire Fighters Service was developed under the World War II Office of Civilian Defense. But this cooperation continued after the war emergency was over, and is resulting in an efficient fire organization for very little money. The efficiency and low cost are due to three primary factors.

(1) The cooperative plan reduces duplication of effort where two or more agencies are involved.

(2) The personnel and equipment of all agencies form a pool for common use in prevention, presuppression, and suppression activities.

(3) The cooperative plan appeals to the taxpayer because it demonstrates a united front by all levels of government.

The land ownership pattern of the State, and the nature of its fire control organization, will help the reader in understanding our problem, and our methods employed in its solution.

Utah is a public land State. Seventy-two percent of her total area is federally owned. The largest single Federal landowner is the United States Bureau of Land Management with some 24 million acres, followed by the United States Forest Service with nearly 8 million acres, the Indian Service with 2½ million acres, the National Park Service with 285 thousand acres, and the Soil Conservation Service, Bureau of Reclamation, and others administering a small acreage. The State Board of Forestry is responsible for 6 million acres of forest and watershed land owned by the State, counties, municipalities, and individuals.

Generally the national forest lands occupy the higher mountain areas and are solid blocks, but in a few instances there occur sections or half sections of alien lands. The United States Bureau of Land Management lands are interspersed with other Federal, State, or private lands. Most of the State lands were acquired by educational grants, at the rate of four sections (2, 16, 32, and 36) per township. These remain largely in their original ownership, and are scattered throughout the State, or if they have been sold to individuals

a checkerboard pattern of public and private lands exists. The result of these ownerships is a diversified pattern in many areas, or at least an intermingling of two, three, or more ownerships.

The State forest fire law places the fire responsibility on the county sheriff and his staff in the absence of a county fire department. The State Board of Forestry and Fire Control hires some temporary guards during the fire season, but the fire responsibility begins at the county level. Therefore, in the State we may have, in a given area, from two to seven responsible fire protection agencies, and this, without coordination and cooperation, could result in considerable expense, duplication, and lost effort in fire control activities.

With this situation throughout the State the primary land administering agencies expressed a desire to continue the cooperative working relationship built up during the war. The wartime organization was retained, but we called ourselves the "Utah Cooperative Fire Fighters." Our objective was to give the land in the State the greatest protection at least cost. Our organizational structure was a State committee headed by the State forester with representation from the major land agencies, and a smaller committee in each county, under what we chose to call a county coordinator.

The county coordinator may be a park ranger, a county sheriff, a county fire warden, a Bureau of Land Management district land manager, or a United States Forest Service district ranger. The county coordinator's responsibilities were to bring together all interested agencies on a county level. Each year the State committee outlines and sponsors a State-wide prevention program and training school, to be taken to the counties, or groups of counties. In this way the prevention materials and personnel are so correlated that we have eliminated duplication and intensified prevention.

The results of such a program have been gratifying. Several illustrations will demonstrate this. During 1947 many of the district graziers of the Bureau of Land Management were laid off because of insufficient appropriations. However, numerous fires were taken care of during this fire period by the Cooperative Fire Fighters in those areas, and their fire reports were mailed to the office of the State forester. In another case, the United States Bureau of Land Management had a large fire in Juab County which was threatening Indian land. A neighboring county, Tooele, rushed two fire trucks 140 miles, and they spent 2 days on the fire.

During the fire season of 1948 a lightning fire in Millard County grew to considerable size, burning over State, private, and Federal land. In this particular instance 305 men were quickly mobilized from the sparsely populated counties, and because of the training received through the Cooperative Fire Fighters plan they served as an effective fire force. A good illustration of economy in fire operation is reported in Summit County for the fire season of 1948. The State fire warden reports that 16 fires burned 2,373 acres, and the total suppression cost to the county was only slightly more than $100. The warden reports that this success and economy was due to the fact that the Utah Cooperative Fire Fighters had trained railroad crews, road and pipe-line construction crews, State road crews, and local ranchers before the fire season started, and these men were available on short notice for fire action.

An interesting phase of our 1948 State spring training program was the zone meetings for key personnel throughout the State. The major theme was law enforcement. The State attorney general's office detailed an attorney who explained the fire laws and law enforcement technique. This seemed to strengthen our State enforcement program for during the past year we had 22 prosecutions and 17 convictions. Only one of these cases was handled by the office of the State forester. The remainder were taken care of by local officers.

Suppression work has been simplified in many counties by the designation of fire suppression responsibilities through the local county committee. A typical example is in Millard County. The United States Forest Service was assigned a suppression boundary which did not necessarily conform to national forest boundaries. The United States Bureau of Land Management district grazier and the county sheriff were each assigned similar boundaries. None of the boundaries conformed to land ownership patterns but rather they circumscribed areas that were most easily seen, reached, and initially attacked by the respective group. Each agency assumed the responsibility of the first attack on fires within their assigned boundaries. The final cost of the fires was to be assigned to the agency owning the land burned. This system decreased detection time, reduced size of fires, and total cost.

Examples such as these have demonstrated to us the economy of cooperation. We intend to continue the system and develop new reserves of mutual assistance. It saves us money and resources.

Blanket Storage.—A heavy three-ply paper bag, similar to a cement sack, was recently put into trial use for packaging blankets at the Angeles Forest warehouse, in place of burlap covering. Ten folded blankets fit into the bag, which is securely closed at the top by two folds through which 8 to 10 Bostitch, Model No. P–2, staples are placed.

Advantages of this method of packaging over the burlap wrapping are as follows:

1. Cheap containers that are disposable. Burlap covering, when returned from project or fire, is always dirty, dusty, or full of foxtails and burrs. Cleaning of burlap is expensive in man-hours or laundry.
2. Time saved in packaging, requiring only one-fourth the time.
3. Containers are dustproof, mothproof, and somewhat rainproof. Burlap covering will allow dust to penetrate when blankets are in storage.
4. Package that will fit into helicopter cargo boxes and also into the automatic cargo release of a helicopter.
5. Package of proper size and shape for horse pack.
6. Package of proper weight for man pack, approximately 40 pounds.
7. Package which is easy to handle and to store.

Packaged blankets are stored in rows and numbered from bottom to top. When shipped from warehouse, the bundle bearing the largest number is shipped first. Thus, the total number of blankets remaining is indicated at all times (namely, the largest number, times 10).

The paper bags can be purchased locally at $211.40 per 1,000 in lots of 1,000, or $171.65 per 1,000 in lots of 5,000.

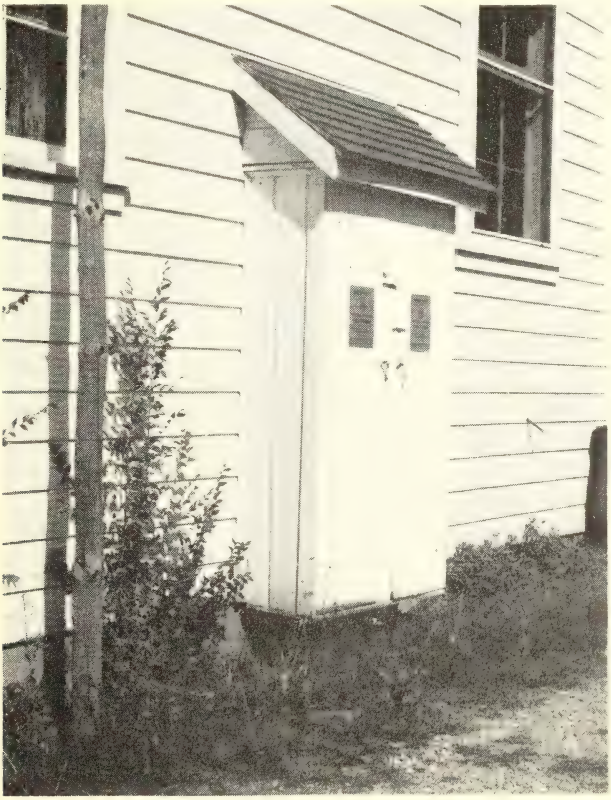
Specifications for bag are as follows: Size, 17 by 12½ by 48 inches; open mouth; three layers—50 substance paper; natural kraft, plain; bottom sewed.—RICHARD GASPARI, *Warehouse Superintendent, Angeles National Forest.*

KAMAS RANGER STATION FIRE TOOL STORAGE BOX

Kenneth O. Maughan

District Ranger, Wasatch National Forest

Fire tool boxes of various designs are widely used throughout the Forest Service with the primary purpose of storing tools so they will be available for anyone needing them. The fire tool box shown makes a practical and well-built cache. It is constructed of the same type material, shingled, and painted to harmonize with the warehouse (white body, green roof), to which it is attached.



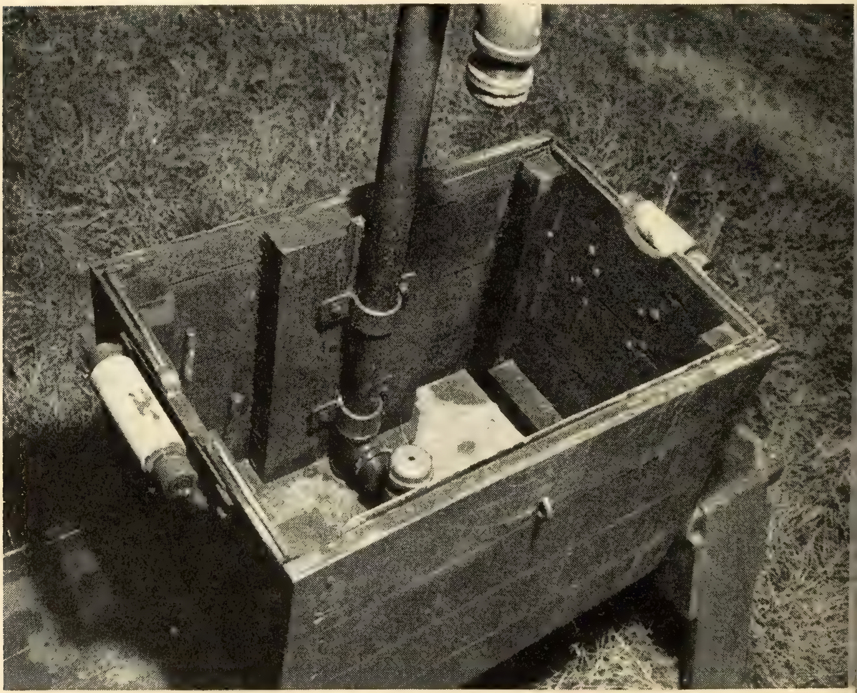
The box is 72 inches high to square, 40 inches wide and 17 inches deep. It is divided into two equal compartments. In one is placed a standard 5-man outfit, in the other a standard 10-man outfit. Tools such as Pulaskis, shovels, and axes are placed on a rack. Rations, files, waterbags, and other items making up the outfits go in the knapsacks.

Each compartment has a separate door, held closed by a simple wood catch. Regular fire seals connect ordinary fence staples driven into the door and into the division board between the two doors so that we may know when the tools have been used and service is required.

Two standard "Fire tool" black and yellow metal signs are used, one on either door to indicate contents of the two sections. The box is not placed on the ground, but is approximately 12 inches above the ground line. This prevents wood decay, makes it handy to get tools in and out, and facilitates keeping the inside of the box clean.

Connecticut Hose Washer.—The Connecticut hose washer was demonstrated at the New Jersey equipment meeting in 1947 and again at Fryeburg, Maine, in 1948. The construction of the washer is illustrated by the photograph.

A wooden frame with a sufficiently wide base is necessary to give stability. Top is hinged for opening to insert hose. Two rolls at front help to guide and flatten hose. Sometimes copper sheets are used as guides instead of rubber rolls. Pipe connections inside box are attached to two hand-made spray nozzles with ¼-inch orifices. These nozzles are set at a sufficient distance above and



Inner works of the Connecticut hose washer.

below line of hose to allow spread of water. Hose is fed through rolls (or coppe sheets) between the two nozzles and pulled from opposite end toward dryin rack. Generally, a set of bristle brushes is attached to the feed end of the bo so that excess mud and dirt may be brushed off before hose enters box. Th washer requires approximately ½ gallon of water per foot of hose at 50 pound pressure to do a good job on dirty hose.—Edward Ritter, *Forester, Region ' U. S. Forest Service.*

LAW ENFORCEMENT IN FIRE CONTROL ON THE CUMBERLAND NATIONAL FOREST

Henry Sipe

Assistant Forest Supervisor, Cumberland National Forest

The history of forest fires on the Cumberland plateau is similar to that for many Southern States. Before the Cumberland National Forest was created, much of this area was burned over annually. Residents of Morehead, for example, say it was a common form of recreation after dark to drive out on the highways and watch the woods burn. In every community the older people still tell how the woods used to burn "every year." While this is probably an exaggeration, it is an undisputed fact that woods fires were a common occurrence.

Burning the woods in Kentucky was a custom handed down from father to son as being beneficial. It was supposed to green up the woods in early spring, kill snakes and ticks, and clear out the trash. Probably this practice stemmed from the setting of fires by the early settlers for clearing new ground, and eliminating hiding places for Indians. Whether these early practices were necessary or not, we know that they existed.

Such was the situation when the Cumberland National Forest was created in 1930. The first work was, of course, appraising values of lands and negotiating options for their purchase. Soon, however, Civilian Conservation Corps camps were established and fire control work got under way. Suppression was the first fire job done. During 1933 and 1934 no record of the number or size of fires was kept. Crews were sent to any and all fires and helped suppress them. In this way the idea became prevalent in places that the Civilian Conservation Corps would help farmers burn their debris—one hears this thought even now at rare intervals. Of course fire tower, telephone line, and road construction was begun. The enforcement of fire laws—and there were such laws, State and Federal—was not given much thought until 1936. A summary of all fires from 1935 to 1948, inclusive, shows the causes as follows:

Causes:	Fires: Number	Fires: Percent
Incendiary	717	30
Smokers	638	26
Debris burning	430	18
Miscellaneous [1]	255	10
Railroads	166	7
Campfires	111	5
Lumbering	47	2
Lightning	39	2
Total	2, 403	100

[1] Miscellaneous are chiefly smoking game out of trees, burning buildings or sparks therefrom, or children playing with matches.

One of the conclusions derived from the above figures is that the best way to reduce total area burned on the Cumberland was to *prevent* fires, as contrasted with a reduction in size of the average fire. There has been no significant change in the average area burned per fire in 14 years. This is primarily due to an average elapsed time up to attack of about 1½ hours. It includes discovery, reporting, dispatching, recruiting men, and travel to the fire. As long as we depend on a "volunteer" warden system backed up by a small core of year-long Forest Service personnel, we seem to be unable to reduce this elapsed time. Strangely enough, even during CCC years there was no substantial decrease in average area per fire.

The first fire prevention activity was probably the use of CCC patrolmen to contact local residents in 1934. These were continued until about 1937 when lookouts and wardens and other local employees were assigned the contact job. About 1943 contact work was given exclusively to lookouts or other regular employees, and this has continued up to now. In 1937 a movie project was set up and one man devoted full time to rural showings for a year or two. In recent years movies have been shown sporadically. For 6 months in 1938 a psychologist lived among the people of the forest, posing as a geologist, studying their attitudes and behavior as related to fires and to the general Forest Service program. Since 1936 most other known means of prevention have been used, such as personal contacts, posters, press releases, exhibits, leaflets, radio, and law enforcement.

Fire prevention efforts have borne fruit on the Cumberland. This effort can be divided into general education, hazard reduction, and law enforcement. Education which was begun in 1934 by CCC patrolmen and enlarged by regular workers in later years, ran into strong adverse sentiment. Many folks were too set in their ways to stop burning the woods or too proud to admit they might have been wrong. It was hard to prove to them how fire prevention could mean dollars in their pockets. Results in the woods seemed too slow. Even today, when farmers are shown how to increase their tobacco income by priming (removing the lower leaves as they ripen before the upper leaves), some are still loath to accept the idea. Education is a slow process at best. And when children are not taught things in school, they will grow into adults faster than forest education can reach them. If parents are unsympathetic, children are inclined to be likewise.

Hazard education has accomplished a substantial decrease in number of fires only along a few railroads, and then only in years and sections when rights-of-way were well fireproofed by burning. This annual burning of sedge grass only makes the right-of-way more hazardous the next year. The Southern Railway is currently cooperating with us in an experiment where the right-of-way is mowed in the fall instead of being burned in early spring. Results have not been conclusive, but I still believe that some other way than burning must be found if the railroad fire problem is to be licked. An important factor is that about half the Southern's locomotives are now Diesels and the L. & N. has several Diesels.

In 1936 a legal assistant was employed on the supervisor's staff; his duty was to push law enforcement. Training schools were held for all regular employees and a law enforcement manual was issued. The objective was to investigate the cause of every fire and take action against the offender. Undoubtedly the bad fire season of 1936 stim

ulated the law enforcement program, if indeed it did not provide the main urge to initiate such work. With only 2 cases initiated in 1935 out of 185 fires, it is obvious that no program existed prior to 1936. In 1936, out of 71 cases initiated, there were only 20 criminal cases concluded involving 31 persons. Of these, 13 paid fines or went to jail (total of 85 days) for failure to pay fines, and 18 had fines suspended. Only 10 cases were settled by collection of damages. This leaves 41 cases that were to a certain extent "duds." Indictment was refused or they were dismissed after initiation. Sixteen of these fourty-one were turned down by prosecuting officials. By present-day rules these 16 fires would not be listed as initiated. Fifty-one letters of warning were written to parties responsible beyond a reasonable doubt for causing fires. This practice of sending warning letters decreased until about 1942 when it was generally discontinued. Table 1 shows certain results of fire control work on the Cumberland since records were kept.

TABLE 1.—*Number of fires and area burned per million acres protected, fire day class, and law enforcement record, Cumberland National Forest, 1935–48*

Year	Per million acres protected		Fire day class			Law enforcement		
	Fires	Area burned	3	4	5	Actionable fires	Cases initiated [1] Civil	Cases initiated [1] Criminal
	Number	*Acres*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1935	414	3, 357				185		
1936	1, 081	19, 335				467		
1937	188	2, 532				179		
1938	205	1, 671				193		
1939	209	2, 123	164	21	2	210		
1940	318	4, 173	132	17		321		
1941	216	2, 966	121	43		192	17	47
1942	129	2, 082	53	26		126	30	53
1943	97	1, 273	103	25		99	28	28
1944	78	1, 351	83	17		82	28	17
1945	57	858	64	11		56	19	9
1946	136	2, 009	54	16	1	131	19	24
1947	93	1, 426	50	4		89	14	8
1948	79	848	63	5		76	15	5

[1] Cases initiated 1935–40 were not separated into civil and criminal. In 1935, 2 cases were initiated; 1936 71 cases; 1937, 31 cases; 1938, 39 cases; 1939, 40 cases; 1940, 46 cases.

Whether there was adequate preparation for the early law enforcement effort is a question. Although there was general prevention work, it may not have pointed up the probability of law enforcement soon to come. Every campaign to enforce a law must have advance publicity. For example, people need to know when the enforcement will begin, whether first offense penalties will be only a warning by the judge, whether the party responsible may pay the damages through settlement out of court, or whether suspects will be subject to criminal prosecution. All modern public relation methods need to be brought into play.

Forest officers in the early years faced many obstacles. In studying and overcoming them, guides have been established for meeting current situations and for training personnel. It was found that judges and prosecuting attorneys had to be interested in fire prevention and forest management activities. In addition, the voters who elect these officials had to be "sold." Interested judges will usually issue warrants; attorneys will allow witnesses to testify before grand juries; and sheriffs will serve warrants and subpoenas promptly.

Informed officials will see that docketed cases are not dropped or dismissed and that fines are paid, not suspended. Some judges have authority by law to suspend judgments (circuit judges in Kentucky), while others do not (county judges). When a replevin bond is given to pay a fine within a stated period, the cooperative judge will insist on its payment. A defendant will often plead "poverty," and a good judge will recognize that a fine or penalty within the defendant's means will insure that future fires that tend to make the poor poorer will be prevented.

Many fires on the Cumberland have been caused by juveniles. Juvenile judges will cooperate with forest rangers by placing juveniles on probation for a specified period, usually in the custody of the parent. The parent is really the one responsible, but of course cannot be prosecuted for an offense committed by the child. Judges sometimes require juveniles to erect fire prevention posters or write essays on conservation.

It is not essential that a case be "won" in order to accomplish good results. One example of this was a youth who set 17 or more fires along a road one afternoon; the evidence was quite clear. The court officials were not sold well enough in this instance to render prompt action. As the boy was to be inducted into the armed services, the landowner and forest officer secured the warrant and arrested the boy when he came to visit his girl friend. He made bond and slipped off to the recruiting center. However, the grand jury returned a true bill and the Army sent the boy back for trial. After the prosecutor outlined his evidence, the judge allowed a directed verdict of dismissal. There have been no fires in this area in the 5 or 6 years that have since elapsed.

Among the defenses that a defendant will set up, the forest officer must be alert to offset these: (*a*) he has a job promised to him, if he is acquitted; (*b*) he is the only source of dependence for an aged and helpless mother; (*c*) he is feeble-minded; (*d*) he didn't "abandon" the fire; (*e*) he "fit the fire" till he was exhausted.

Forest officers must assure themselves that needed witnesses will be at the trial, whether summoned legally or not. If your witness refuses to be sworn or to testify, trouble is brewing. One key witness was murdered before the trial.

The principles and cautions above outlined will be found to be helpful in Federal court cases as well as in State courts. The United States judge and attorney (or an assistant who handles your cases) are key individuals and should be well informed of the forest objectives. The marshal and his deputies can be of great aid in serving papers promptly.

It is essential of course that the law enforcement policy be clearly set forth and understood by all persons who are to place it in effect.

Many employees are as reluctant to participate in legal affairs as is the average citizen today.

One of the important parts of such a policy is to decide the degree to which cases will be initiated. By that I mean, shall cases be initiated only (*a*) where the party responsible is willing to plead guilty, or (*b*) where guilt is clear beyond a reasonable doubt, or (*c*) where there is some question of guilt. It is very desirable to have an "open and shut" plea of guilty case to initiate before a new judge. This allows him to become familiar with the law violated, the possible penalties, and renews his acquaintance with the investigator. After this, more and more difficult cases can be taken before the same judge with more assurance of receiving sympathetic consideration.

Some judges like to handle civil cases and do not like to decide criminal issues. In this event, a judge with concurrent jurisdiction elsewhere in the area may be located. This is true in Kentucky, where magistrates have equal jurisdiction with the county judge.

After an enforcement program has been started, it is essential that it be maintained at a steady and consistent level even though there is a change in personnel. Too often a new ranger will undo the work of several years of steady enforcement.

It is not necessary that all forest officers be highly trained specialists in law enforcement. Give men of reasonable intelligence some training, put the administrative urge behind them, keep up a sustained and persistent effort, and you have the essential elements of a successful program.

In 1942, representatives from important industries and utilities, as well as public employees of major resource agencies, were given training in Army camps to combat sabotage. This training was conducted by FBI personnel and other authorities in their respective fields. The Forest Service selected me as one of its representatives to go to Fort Oglethorpe, Ga., to receive training in such things as complaints, warrants, arrests, searches, investigational methods, various kinds of clues, sources of information, handling evidence, photography, ballistics, sabotage methods, court procedure, admissibility of evidence, and report writing.

Upon my return to the Cumberland, a 3-day training meeting was held at Cumberland Falls State Park for our forest rangers and guards, foresters from nearby forests, and State forest representatives. Most of the Fort Oglethorpe subjects were covered in abbreviated form.

This training stimulated the law enforcement work already begun in the spring of 1942 and resulted in more cases initiated and a good percentage of convictions. In the last year or two the records will indicate somewhat of a let-down. This can be traced to two factors. First, the fires are of the more difficult type to solve. Debris-burning fires—usually easy to solve—have just about disappeared. The bulk of the fires are now hunter, smoker, and incendiary fires—all tough ones. Secondly, it has been difficult to maintain an administrative urge. The war is over, "emergency" measures are not popular, and the timber sales activity is at a peak.

If the number of fires continues to stay below or close to 100 per year, the fire occurrence objective is being met. It is not denied that weather has been on the damp side in recent years. However, one cannot

travel in any part of the forest without being informed by local residents that fires are rare because "folks is a-skeered to let fires get away." (And I say "rare" because the risk on the Cumberland is tremendous. Thousands of people are in the woods much of the time.) Further questioning will usually bring forth the definite claim that the "woods is growing up a lot greener than it used to."

Forest administrators exhibit a wide variation in aptitude and desire when faced with law enforcement. Some just don't like to get into court; a few take to it naturally. Many of the characteristics of a good investigator are also qualities that make for general success in life. For example:

1. A righteous indignation against wrongdoing.
2. Common sense, good judgment, and tact.
3. Aggressiveness and persistence.
4. Resourcefulness.
5. Thoroughness.
6. Observing and good memory.
7. Technical skill and knowledge of the "modus operandi."
8. Familiarity with local customs, dialects, topography, and knowing the people themselves—for example, who lives where.
9. Ability to write a good report.
10. Intellectual honesty.

It is not entirely the fault of unit managers that their law enforcement records are sometimes pitifully poor. Their superiors often turn thumbs down on legal action for fear of stirring up trouble, political or otherwise. Perhaps just as important is the fact that foresters receive very little, if any, law enforcement training in college that would come anywhere near preparing them for the first major test of their professional career in fire control. I cannot agree that this is entirely an on-the-job training subject. I believe all forestry schools should include somewhere in their curricula at least the following subjects:

1. Qualities of good investigators.
2. Methods of investigation (observation and description, interrogation, surveillances, undercover work, and entrapment).
3. Laws and statutes.
4. Equipment used.
5. Clues: footprints, tire tracks, tool marks (especially axes), fingerprints, firearms—exploded shells, etc.
6. Marking, handling, and preserving evidence (for example, making plaster casts.
7. Complaints, warrants, arrests, bonds, summons.
8. Trial procedure.
9. Evidence in court (admissibility, witnesses, what must be proved).
10. Report writing.

It may be argued that it is the prosecuting attorney's duty to handle many of these details for you, and indeed it is. An investigator is likely to find, however, that an attorney who has not been "sold" on your work is more than likely to be on the defendant's side.

Perhaps some examples of the application of science to fire problems will emphasize my points. A bee tree was cut in Rockcastle County and plenty of ax chips were on the ground. The ranger visited the nearby residents, checked chips at woodpiles, tried axes and soon came up with chips that matched. Considerable thought was evoked in the community, and although the case was not initiated in court for various reasons, few fires have occurred in that area since

then. The owner of the ax maintained his innocence, but everyone in that community knew who got that honey.

In another typical case ax chip marks were matched. The owner of the ax at first denied all knowledge of the affair, but soon admitted that two boys had borrowed his ax to cut down a chestnut tree to smoke out a squirrel. The boys owned up and paid damages.

To properly compare ax marks, chips should be taken from similar wood species and before the ax has been sharpened. Also chips must be taken with right and left hand swings, and with both edges if the ax is double-bitted. Every dent or gash in the edge of the blade will be visible on the top of the chip when it is held so the light throws shadows across the lines.

Occasionally unusual clues will be uncovered. One alert ranger, searching carefully, found a lock of singed hair caught on the root of a stump inside a burned area. Horse tracks led from here to a nearby farmhouse, where the animal was found. The owner admitted riding through the area but denied causing the fire. The ranger obtained a lock of the suspect's hair. Both locks were sent to the FBI laboratory, which replied that they were similar in every major respect. Confronted with this evidence, the suspect admitted he'd been drinking and had fallen off his horse, which ran home. He had then lighted a fire to warm himself; and, when it scorched him, he jumped up, bumped his head on the stump, and left without extinguishing the blaze. He paid a fine in county court.

The laboratory facilities of the FBI stand ready at all times to give expert opinions on all types of evidence. If requested, they will furnish an affidavit. In important cases they will send an expert to testify at the trial. Ordinarily they prefer to assist in field investigations only in incendiary cases and where Federal property is burned or threatened.

One technique every investigator should know is how to make plaster casts. These are valuable in cases involving footprints or tire tracks. Ordinary plaster of paris, obtainable at a drugstore, is sifted slowly into cool water until a thick cream is produced when stirred. This is poured carefully into the track and reinforced with sticks. It sets in 10 minutes or so. It can be removed and, when further dried and gently washed clear of dirt, reveals the track in detail.

Not far from Cumberland Falls tracks of two persons were found near several burned buildings. The fire had spread to the woods. Casts were made which later matched those of two suspects. There had been previous feuding in the vicinity. These parties were brought to trial in State court, but due to "technicalities" the case was lost. However, there have been no more fires in that area.

In the previous case a bloodhound was used to locate the persons who made the tracks. The Cumberland bought two bloodhounds in 1941. One was half foxhound, but could trail as well as the other. In any area where a concerted major effort must be made to curtail incendiarism, a bloodhound will pay for itself. Although easily handled, a dog requires considerable exercising.

In an area where numerous small fires are the rule, I believe it is unwise not to send an investigator either with or before the suppression crew. A crew usually destroys what few clues may have been left by the person who caused the fire; a few acres are saved, but the causative

agent goes unpunished and more fires occur. If a choice existed, it might be better to begin a law enforcement program a year in advance of a suppression organization. This might stimulate local residents to organize really volunteer crews with only nominal outside help.

The Cumberland has a net acquired area of 433,000 acres, but the Federal lands are highly checkerboarded. Thus it is necessary to protect some 524,000 acres of interspersed private holdings. Around the edge of the million-odd acres we protect are other private forest lands. Although a little of this is protected by the State of Kentucky, the majority receives no organized protection.

Undoubtedly the fire influence of the Cumberland National Forest extends beyond the million acres we protect. People are constantly moving from one area to another. This very fact, however, subjects the Cumberland to increased risk. Outsiders, who want to burn carelessly, move in and have to be "educated." Often the education begins only after they have allowed a fire to escape. Our "protective boundary" usually follows some road, stream, ridge, or county line. On adjacent unprotected land, people let fires escape with impunity. As 100-percent fire protection is approached, outsiders moving in will already have been exposed to fire prevention ideas.

It is my contention that every case well handled, regardless of whether it is won or lost—and by that I mean thoroughly and tactfully investigated and prosecuted—will in the long run reduce the number of forest fires.

COOPERATIVE FIRE SUPPRESSION ON THE NICOLET

E. W. Zimmerman

District Ranger, Nicolet National Forest

The district ranger muttered to himself as he turned off the county runk road onto an old woods road. Why was it the spring fires always ccurred in the back country when the side roads were practically mpassable? The pickup pumper truck he was driving and his crew f five men could knock down most of the spring fires—if they could et to them soon enough. But that was the catch—after they left the ıain roads, they had to travel soft, slippery roads with high centers nd panbusting boulders. He had requested a high-clearance, four-vheel-drive truck for just such conditions but those things take time.

Just ahead was a particularly bad looking piece of road. It was ome distance to the fire and they had to get a lot closer if the pumper vas going to be of any use to them. He gunned the motor and plunged nto the mudhole. The truck slid to the side and promptly came to a top as the rear wheels dropped into a deep rut. Sure enough, they vere stuck. The crew jumped out and began to block up the wheels s the ranger gave the dispatcher a call on the radio and advised him f the situation.

After 30 minutes of hard work, they were able to get the truck hrough that mudhole and the one just beyond. The ranger was nxious. With this wind and all the elapsed time, they would without doubt have a class C fire by the time they arrived. The old road urned and ran along side the railroad track and they could see the ire up ahead. This must be a railroad fire, but it seemed very small nd certainly wasn't moving at the rate the ranger had expected. uck must be with us, he thought, considering the excessive attack ime we are very lucky indeed; but wait, there is a man working on the ire, beating it with a pine top—there's another man —and another— ll beating at the fire with great vim and vigor.

The ranger and his crew jumped out to help the three-man crew lready on the fire. In a few minutes the fire was under control. The rea burned was small. The ranger knew these men, a local farmer nd his two sons. They had seen the smoke from their east field where hey were plowing and had cut straight across country to the fire which vas not more than an acre in size when they arrived. They expected o compensation for their work as they felt they were protecting their wn property as well as that of the Forest Service, and then too, they id not want to see that young plantation burn—the one the Forest Service planted some years ago about a quarter of a mile north.

The ranger was grateful because, as he looked over the surrounding rea, he realized this fire could have developed rapidly and become project fire if the farmer and his sons had not been close and had not aken immediate suppression action.

This free will initial action is typical of the cooperative fire suppression which takes place on many ranger districts every season. Yet, this extremely valuable form of cooperation can be greatly enlarged to the everlasting benefit and protection of our timberlands. Enlarging a program of this sort presents many difficulties and discouragements; not the least of which is the practice, created through necessity, of paying for all fire fighting work. We cannot avoid hiring men for fire suppression work, nor can we anticipate the complete and over-all control of fires by cooperators. To approach even this glorious ideal is more than we can expect from local people who have their own lives to lead. Then too, there are some who will ask, "What's in it for me?" Have we an answer which will satisfy these individuals? Lack of local settlers in critical areas limits the possibilities on some districts.

In spite of these and other unfavorable aspects, there must be ways and means of increasing the amount of cooperative fire suppression. It would seem that we should lay the ground work in advance—that we should make a particular effort to build good will among the settlers in isolated areas. Here again we face obstacles; district personnel is subject to frequent transfer and, to a lesser extent, settlers move from critical areas and new people move in.

The proposed good-will program involves time, effort, and education. Ours is the task of convincing the district residents that they have enough at stake to justify their taking time to put out small fires. We have come a long way in our program of showing people they have enough at stake to *prevent* fires; now we must ask them to go a step further. Cooperators gain a source of satisfaction from doing a service to the community. Our job is to foster and develop this feeling and to see that these individuals gain recognition for this service. The task is not simple. The human struggle for the material things of life does not parallel our purpose, nor can we develop an efficient corps of cooperators overnight, but the ultimate goal is well worth striving for.

AIRCRAFT IN FOREST FIRE CONTROL IN NEW YORK [1]

F. C. McLane

New York State Conservation Department

Someone said once that "Time is the essence and custodian of all experience." Time, relatively speaking, is just as important a factor to the business of forest fire control as it is to our daily lives. In this forest fire control business we have formulas for calculating the rate of spread of a fire; for calculating its probabilities; for calculating the number of men needed to check its advance in a given period; for estimating the damage done; and for many other things. We have factors and equations entering into problems of fire behavior; methods of attack; fire line construction, mechanical and otherwise; etc.—all necessary to do the best possible fire suppression job. But when it comes down to the final analysis, the result of our work, whether good or bad, is dependent primarily on time.

Naturally, then, the speed and accuracy with which we do things has a definite bearing on the conservation of the time element. Specifically, the modern plan of forest fire control is founded on speed. It is designated to reduce, insofar as possible, the most dangerous factor: lapsed time—the interval between the inception of a fire and the time that actual suppression measures may be undertaken. To reduce this time to a minimum, we must be constantly on the alert to develop and adopt new techniques and equipment, and to devise suitable and efficient ways to use them. The struggle against lapsed time begins with the prompt and accurate detection and reporting of a forest fire, and is followed up by promptness in dispatching fire suppression crews and equipment to the scene of the fire.

Many new devices have been adapted to modern forest fire suppression and great advances have been made in the development of forest fire control equipment in the past decade. One of these time-saving developments is aircraft.

We purchased our first airplane back in 1931, and since then we have used our aircraft to what we believe to be the best possible advantage, amassing nearly 15,000 of the roughest, toughest, and nastiest flying hours. Flying was done under all conditions and, up to 2½ years ago, with one, single-engine airplane that was replaced periodically. We feel justified, also, in being proud of our safety record.

The first airplane was used in systematic patrol for the detection of forest fires. The initial patrols were made in a fire control district lying southeast of the Catskills and at the back door of Metropolitan New York City, because the detection system there was inadequate, and nearly 25 percent of all the forest fires in the State were occurring there at that time.

[1] Condensed from paper presented at a meeting of State fire protection officers, Bearbrook State Park, N. H., March 17, 1949.

The results of the first year were encouraging. It became increasingly evident that aircraft had possibilities of fitting into any situation where time, distance, or transport entered the equation. But its use was definitely limited because of lack of air-to-ground communications. This missing link was supplied in the following year, 1932, by the installation of two-way radio. With each ensuing year the airplane achieved greater success in the reduction of fire losses. As our airplane was replaced from time to time by new and improved types, new uses were developed. Most of these developments were spectacular at first. Today, aircraft has become one of the most effective tools in the hands of our forest fire control organization. It fits solidly into our plans and is a definite "must" if we are to keep abreast of modern fire control developments.

We don't know all the answers to our fire control aviation problems. On the other hand, we feel that in 18 years of using aircraft in forest fire control we have acquired a background of considerable experience in the application of aircraft. What we have determined to our own satisfaction is—

1. That we have only scratched the surface, as far as the use of aircraft is concerned.
2. That there is plenty to be accomplished.
3. That certain, specific types of aircraft are more adaptable for certain assignments than others.
4. That no one piece of aircraft equipment available on the commercial market today is ideal for meeting the variety of complex fire problems we have to cope with in New York State.
5. That the airplane is a fast and adaptable piece of machinery necessary for effective forest fire control.

What have we done with our aircraft, in these 18 years of operation that has made it such an important cog in our forest fire control machinery? These activities fall into nearly every phase of forest fire control including prevention, presuppression, detection, reporting, suppression, scouting, and the estimating of burned areas and damage. Suppose we make a quick analysis of each of these seven phases.

Prevention.—The airplane has a definite psychological value in the areas in which it operates. The attendant radio and newspaper publicity, coupled with the airplane flying overhead, makes people surprisingly forest fire conscious, especially in areas where fire permits are necessary. In this connection, I have heard a responsible State official who witnessed this phase of operation say, "The airplane is the most effective single forest fire prevention medium in effect in New York State today."

Presuppression.—Strong presuppression action, so as to catch fires when small—rather than greater suppression action, aimed primarily at keeping 10-acre fires from becoming 200-acre fires—is one of the cardinal principles of our forest fire control organization. The airplane plays a part, directly or indirectly, in most of our presuppression planning. The patrolling of State land and areas where fires are numerous, with an eye for such things as logging operations, blow-down areas, etc., helps tremendously in compiling current slash maps or maps of high fire hazard. Registration of intended cutting by lumber operators is not required in New York State, consequently many logging jobs are well under way adjacent to and outside ou

forest preserve before we are aware of them. Obviously, the degree of fire hazard depends on the size of the job and its location. Slash maps and maps of high fire hazard are of major importance in planning appropriate suppression action when a fire is reported.

In remote areas of probable fire hazard the construction of proper facilities for storing fire fighting tools and housing personnel is one of our presuppression measures. Four such buildings were strategically located in our forest preserve, and we had the occassion last fall to erect another on the shore of a small lake in a very remote section. It was necessary to transport 20 tons of materials 22 miles to do this job. Twenty-three trips by plane in 3½ days moved everything. Each round trip, including loading and unloading, averaged 55 minutes. At the loading point, trucks backed up to the airplane. The unloading point was just 60 feet from where the building was erected. It would have taken a tractor and jumper, with maximum possible load, 132 days to do this job. Figuring tractor hire, labor, time, weather, etc., we determined that with our Grumman "Goose" amphibian we did this job in one-fortieth the time and at one-half the cost.

Detection.—In my opinion, the airplane will never entirely replace the highly developed tower detection system we have in New York State today. This has been borne out, not alone by our own experience, but also by the experience of the Civil Air Patrol on forest fire detection during the war. On days when visibility is definitely restricted because of haze, smoke, etc., our single-engine "Navion" is of definite value in detection. In these cases, we are able to eliminate tower guesswork by definitely establishing the location of a fire.

Reporting.—We can pinpoint the location of a fire, size it up as of that minute, and give by two-way radio pertinent information such as size, rate of spread, strength of attack needed, where water (if any) is available, location of natural barriers, etc. We can make an immediate appraisal of its probabilities and, if necessary, organize follow-up attack strength, even before the initial crews arrive at the fire.

Small smokes deep in the forest are investigated and reported. Some of these smokes demand immediate suppression action. In many cases investigation has proved these smokes to be safe camp fires, and many a forest ranger and crew has been spared the task of carrying heavy fire fighting equipment many a weary mile on a false alarm. When a ranger leaves for a fire there is no satisfactory way of knowing where he is or what's happening to him unless he is equipped with radio. Obviously then this is not alone a saving of time, money, and effort, but, just as important, that ranger, with his crew, is not "lost" at a time when, perhaps, he may be needed most.

Suppression.—Speed of attack is our keynote. It is a major factor in the progressive reduction of fire losses. In actual suppression we are able to guide the fire fighters directly to the scene of the fire, and, in many cases, direct the actual initial attack. We are able to control men and equipment at all times, whether en route or actually working on the fire line. We can concentrate all forces on one fire or divide forces to take care of several fires as the occasions and conditions warrant. All this is effectively accomplished from aircraft because of the commanding view of the situation. It has its psychological value too, because the men on the ground know that the

airplane is watching out for everything, including fires in other parts of the district. One swing around any fire and there are no loafers on the fire line.

Transportation of supervisory personnel and equipment quickly from one fire to another or from one end of the State to the other is extremely valuable, especially for large fires. As a matter of fact, we transported personnel and equipment to one 10,000-acre fire and thereby saved the lives of 15 persons. Actually, if it is a matter of equipment only, we can deliver hand tools and power pump accessories, including gasoline, by dropping them directly on the fire line. We are furthering our cargo parachute dropping project this year.

Scouting.—Reports on the current progress of any fire is of paramount importance to the men in charge on the ground. These reports can be quickly and easily made from the air. They include calculating rate of spread; informing crews of outbreaks along the fire line, etc.; locating spot fires as they occur and guiding crews to them; and, patrolling the fire after it is under control. In this latter category, it is our general practice to make early morning patrols to catch outbreaks on the line before the heat of the day has its effect.

Estimation of Burned Areas and Damage.—To say that we are able by airplane to estimate burned areas and damage usually within 5 percent may sound fantastic, but it is nevertheless true. The method of estimating is based on actual surveys on the ground. Our largest recorded error in 12 years of using this system was slightly over 6 percent on a 690-acre fire.

Any study of our modern forest fire control methods may well take into consideration the American tempo, the eternal quest for doing things quicker and more efficiently, as typified by our efforts to "streamline" our living and working conditions. This pace is reflected in our forestry practices, our watershed management, and our recreational habits. All this has a profound effect upon forest fire control. Today we are called upon to fight fires which are directly the result of this American tempo; fires which demand of us the promptest kind of response and the use of specialized apparatus and equipment, such as high-speed water-carrying trucks, power pumps, ditch diggers, fire line constructors, airplanes, and parachutes, that might never have been dreamed of even by a "Jules Verne" of our original forest fire control organization.

The use of aircraft in forest fire control in New York State has been tried and proven. Each year adds to our experience with, and knowledge of, this use of aircraft and to our dependence on it. However we are still not making fullest possible use of aircraft. This will be our goal in the near future. Who knows but that in the not-too distant future foresters, even those who doubted the value of aircraft may be directing the actual attack on a fire from behind desks 100 miles away, through the medium of aircraft, radio, and television.

Volume 10 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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Contents

BROADCAST SLASH BURNING AFTER A RAIN[1]

Robert Aufderheide and William G. Morris

Pacific Northwest Forest and Range Experiment Station

Slash burning after clear cutting in the Douglas-fir region has been previously discussed in pamphlets published by the Oregon State Board of Forestry, Washington Forest Fire Association, West Coast Lumbermen's Association, Western Forestry and Conservation Association, and the United States Forest Service and in several trade journal articles. The authors claim no originality for the material in the following article but believe the points discussed are worth reconsideration. Some of the suggestions will probably be new to readers who have not closely studied the methods of slash burning used in different parts of the Douglas-fir region. The origin and adoption of the policy to burn slash as soon as it becomes inflammable during the clearing weather immediately after a rain instead of waiting until just before the next rain is expected has not yet been definitely dated. The State Forester of Oregon states that his organization has followed it in the Douglas-fir region for a number of years. Several of the national forests in the Douglas-fir region have followed this policy in recent years.—*Ed.*

Broadcast burning of slash in the Douglas-fir region is often done just before an expected heavy fall rain. If the rain occurs in sufficient quantity at the right time, no work is necessary to confine the fire to the slash area. If the expected rain does not occur, it is often difficult to confine the fire to the slash area. Furthermore, burning just before

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A slash fire burning with moderate intensity when the ground is still moist from a preceding rain leaves unburned beneficial humus in the topsoil.

[1] Reprinted from the September 1948 issue of West Coast Lumberman.

a rain is open to other criticisms. In contrast, recent experience shows that burning after a rain, as soon as slash is dry enough, has several advantages.

The forestry objectives in burning slash are: (1) To remove flashy small material in which dry-weather fires spread with such speed and heat that they can seldom be controlled inside of the slash area; (2) to burn apart crossed and closely lying logs, separating them where great heat can be developed and thus make an accidental fire more

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When the weather begins to clear after a rain, slash in a clear cutting will be come dry enough to burn while the litter in the green timber is still moist.

intense and difficult to control; (3) to check the growth of brush tha sprouts from roots established before logging and competes with tre seedlings; (4) to remove excessive debris that would prevent tree seeds from reaching a suitable seedbed; (5) to accomplish as far as possible the foregoing aims without scorching adjacent standing timber or causing undue heat injury to the soil and seed trees within th slash area.

ADVANCE PLANNING

With such objectives, slash burning helps keep forest lands productive. It is not just a clean-up job to be done after the cutting under any conditions the operation may create; it is an important part of th cutting operation and, like other phases, should be efficiently coordinated. Plans for broadcast slash burning should be started long

before the burning season. Some of the greatest difficulties and risks can often be eliminated if the slash-burning job is carefully considered in the cutting plans.

Good planning will avoid the following difficulties and risks: (1) Slash areas too big to be burned in 1 or 2 days by firing successive narrow strips along the contours, beginning at the top of the slash area. A slash fire that runs unchecked a long distance up a slope usually creates excessive heat. (Staggered settings of 80 acres or less facilitate slash burning, especially when periods of good burning weather are short.) (2) Equipment and logs situated alongside considerable slash with no firebreak to isolate them at the time of the first burning season. (3) Current slash joined with that of another owned. (4) Tops felled into the adjoining green timber. (5) No firebreaks, such as ridges, streams, rock outcroppings, or roads, around the slash.

Advance work should also include a detailed plan of the burning jobs, outlined on paper well ahead of the burning date. This should provide: (1) A description of the weather and fuel moisture conditions desired. (2) Desirable time of day to begin setting fires. (3) A sketch of the area showing topographic features, boundaries of the area to be burned, and the order in which different parts of the fire will be set if the prevailing wind direction for the locality occurs. An alternate order of setting for another wind direction may be desirable. (4) Number of men needed to do a good job, and their specific assignments. (5) Estimated length of time to set the fire and to patrol and mop it up. (6) Number of torches, amount of oil, and other firing equipment. (7) Placement of portable pumps and tank trucks for fire control use. (8) Hand tools and bulldozer (on the job) for emergency use. (9) Communication and arrangements for extra fire control help if needed.

Finally, two parts of the slash-burning job should be done, if possible, before the burning season. All snags inside the slash area and any outside but near the area boundary should be felled. A fire trail should be built along adjoining cut-over areas, certain open types of standing timber, and other critical edges. The decision on the need for advance fire lines will depend largely upon the nature of the slash, the topography, adjacent timber conditions, and availability of adequate manpower for mop-up. Bulldozer fire lines, particularly on sidehills, have the disadvantage of mixing much dirt with the slash to be burned; this causes fire to smolder a long time on the edges of the slash area. If a bulldozer is used, the dirt and debris should be pushed away from the slash area to avoid a smoldering fire at the line.

CHOOSING THE SLASH MOISTURE CONDITIONS FOR BURNING

Since one objective of broadcast slash burning should be to avoid undue heat injury to the soil, seed trees, and adjacent timber, the soil should be moist in both the slash area and adjacent areas. Yet to allow economical fire setting the fine material should be dry enough to carry fire and be easily kindled. In the light of these requirements,

fall burning just before an expected rain presents several disadvantages:

(1) The soil, duff, and logs on the slash area will usually be dry. Such slash generally burns too intensely, and a hard burn is destructive to soil structure, soil humus content, and seed trees.

(2) If the slash is very dry, the adjacent areas also will be dry. Under these conditions, numerous spot fires and break-aways can be expected; this increases the cost of control and causes loss of adjacent timber, equipment, or other values. Even though timbered areas may be fairly damp, the exposed edges for several hundred feet inward may be almost as dry as the slash area. Hemlock and spruce, which are particularly susceptible to fire damage, will die from the effects of a ground fire around their bases.

(3) The timing and intensity of a rain storm in a given small area are difficult to forecast.

(4) Most storms are preceded by strong winds; this will increase the danger of break-aways and damage.

(5) If the rain begins sooner than expected, there generally is an urge to fire the slash rapidly. When this happens, a hard burn is the usual result, and frequently uncut timber around the edges is scorched. Sometimes the slash quickly becomes too wet for the set fires to spread. Instead, they smolder and burn in the concentrations without completely dying out; real danger may occur later with a change to low humidities and increased wind velocities.

(6) The expected rain may not occur. A serious fire problem may confront the burner in this situation, depending upon adjacent timber conditions and subsequent weather.

TREND SINCE 1942

Since about 1942 there has been a trend toward doing fall slash burning immediately after a rain. This method has definite advantages in avoiding heat injury and providing good conditions for burning:

(1) As fast as the fine slash and surface of the coarse slash become dry after the rain, the slash is burned. Since the duff is still wet below the surface, it is completely burned only in the spots beneath logs or piles of hot burning fuels. On the remaining area the fire destroys the light and flashy fuels but dies out before consuming the duff and humus in the soil.

(2) The fine slash will dry out first while the fuels in the adjacent green timber are still wet. The wet duff and damp litter in the timber will lessen the danger from spotting and break-aways. In many instances when slash is burned under these conditions, advance fire lines are unnecessary.

(3) The first few clear days following the rain are usually calm and offer ideal conditions for controlling the burn.

(4) The materials in which the fire spreads can be burned out before dangerous weather develops.

(5) Under this method it is possible to do the slow burning that does the least damage to forest soils, seed trees, and surrounding timber. More time is usually available for setting the fire in successive

contour strips down the hill. This avoids a sweeping and excessively hot fire.

(6) Where one person or one crew has responsibility for burning a number of slash areas, this system offers a longer period in which to do the job. In this way experienced slash-burning personnel can cover more ground, and better burning results are probable.

In any broadcast slash burning, good judgment in picking the right time to burn is essential to success. The decision on whether to burn early or late in the season will be determined by the general location of the slash area and the burning conditions on and adjacent to the slash area.

WAIT UNTIL 3 INCHES OF RAIN

Burning after a fall rain should not be attempted until about 3 inches of rain have occurred. This will usually be after two or more storms. There should be reasonable certainty that timbered areas will not again dry out that year. Fall rains occur at varying dates and usually begin earlier in the northern part of the Douglas-fir region than in the southern. Coastal slopes also become wet earlier than inland areas. Good burning conditions ordinarily occur in inland areas between October 1 and 20, and along the coast between September 10 and October 1.

A large slash area adjacent to other highly inflammable areas is more dangerous to burn early in the fall than a small slash area surrounded by green timber. Where high-risk burning chances occur, it is advisable to burn late. However, good slash-burning results cannot be expected consistently on such chances regardless of the time of burning. By planning the logging operation well, however, many of the risks can usually be eliminated or minimized. The poor slash-burning results obtained on most dangerous slash areas happen largely because management permits difficult situations to occur.

In stream bottoms and on north slopes on the coast fog belt where dense brush grew before logging, slash should be burned fairly early in the season after the first fall rains occur and under fairly dry burning conditions. This is done to obtain the best possible regeneration of conifers. One purpose of such burning is temporarily to set back the brush in order to give natural regeneration or planted stock a chance to become established. The coastal brush is more of an obstacle to adequate natural reproduction than is commonly appreciated. Unless burned with sufficient heat to kill the tops and injure the root crowns, this brush springs up rapidly when exposed to full light following logging. It will then hold the area it occupies and exclude conifer seedlings.

THE DAY TO BURN

It is advisable to burn as promptly as possible after the rain—as soon as the small materials and log surfaces have dried enough to ignite easily and while the lower duff layer in the slash and all fuels in adjacent timber are still damp. In selecting the best day, the dampness of the duff should be determined at several points in adjacent timber and in the area to be burned by digging into the duff

with the hands. The inflammability of fine fuels can be estimated by the brittleness of twigs. A better method is to burn a small sample of fine slash. If the fire will not spread, burning should be discontinued until conditions improve. Best results are obtained when the fire spreads slowly and many sets are required to ignite the entire area.

Even though the relative humidity is low, the fire can be easily managed if the air is calm and the duff is moist. Successful, controlled, nondestructive slash fires have been observed burning under these conditions shortly after a rain when the relative humidity was only 25 percent.

Weather Bureau forecasts should be studied before burning and also after burning is under way. The Weather Bureau wishes to assist with slash-burning projects and is glad to provide fire-weather forecasts.

SETTING THE FIRES

In setting the fires the most dangerous edges should be lit first and a safety strip should be burned around areas to be left unburned. Topography, and condition of the slash should be considered in the firing progression. In all cases the uphill and leeward sides of the area should be fired first. It is best to proceed slowly at first, and edges should be well burned out before setting additional fires. Hot, destructive burning can result from setting off too much area at one time.

Once started, burning should be continued until all fuels within the slash area have been ignited, but burning should be discontinued whenever set fires will no longer spread. Smoldering fires scattered through a large area of unburned fuel are apt to produce an undesirably hot fire when burning conditions become more severe during the afternoon of the next day. To avoid this circumstance, it is also advisable to delay setting more fires until about noon the next day or until such a time as they will spread. Frequently, excellent results can be obtained by burning south slopes and dry exposures during the early part of the night, and north slopes, creek bottoms, and other damp areas during the heat of the next day.

MOP-UP

The importance of mop-up to continuing success of slash burning after a rain cannot be overemphasized. In burning immediately after a rain, dryer weather can be expected. After the slash fire has cooled, any live edges should be trailed and mopped up. The proper time to do this mop-up is while weather and fuel conditions are still favorable for moderate burning. The objective should be to have the edges of the burned slash dead before dangerous weather conditions occur. If the slash has been properly burned under the right conditions, a clean burn will be obtained, and not much live edge will remain 24 to 36 hours after the slash has been fired. A clean burn properly mopped up will not spread fire even though the weather becomes dangerous.

Those who have tried this method for a number of years claim that the results are achieving the objectives of good slash burning with less trouble, loss, and expense than burning before an expected rain.

FIGHTING LIGHTNING FIRES ON THE KLAMATH NATIONAL FOREST

T. A. Bigelow, *Fire Control Officer*, and A. L. Morford, *Dispatcher, Klamath National Forest*

One look at the burned-area map of the Klamath for the period 1910 to 1920 and you immediately ask, "What on earth caused such a widely scattered burned-area pattern?" The size of these burned areas indicates a tremendous loss in natural resources to the State and Nation. A quick glance at the statistics reveals the answer, 100 to 150 lightning fires per year. If you follow the records on through the next decade you will observe the same burned-area pattern, except a slightly heavier concentration around the more or less inhabited areas. The same number of lightning fires appear as before, but to it is added a new problem, incendiary sets, most of them set at the same time. It is quite apparent that the Klamath's fire problem is not the occasional single man-caused fire, but rather many fires occurring from lightning and incendiarism at the same time.

The development of a system to handle these concentrations of fires was begun in the 20's and further developed during the 30's. The early 40's saw a well-established method perfected and used to a marked degree of success, reflected in the highly desirable reduction in burned area. However, the average number of lightning fires per year showed some increase, probably due to the success of reaching more fires before they burned together, causing the larger burned areas shown in the early history of the Klamath. A description of the system follows.

In order to handle from 75 to 100 fires, occurring within a 2- or 3-day period over an area of 1,600,000 acres, it is quite necessary to operate under a decentralized plan with a highly trained officer to coordinate the action between the various district headquarters. The supervisor's headquarters organization to coordinate and furnish the service of supply necessary to the districts and the ranger's headquarters organization are shown on the chart.

The fires usually occur in groups of 3 to 8 that logically can be handled from a central point of operation. We have elected to call these coordinating areas, which are under the direction of an area coordinator, who has two distinct types of organization under his command: The first, fire bosses and fire fighters, and the second, service and supply.

This system operates as follows: The lookouts report all fires to the district dispatcher, who locates them and then passes the location on to the area coordinator, who sends out a fire boss and fire fighters. These fire fighters are serviced and supplied by the area coordinator's serv-

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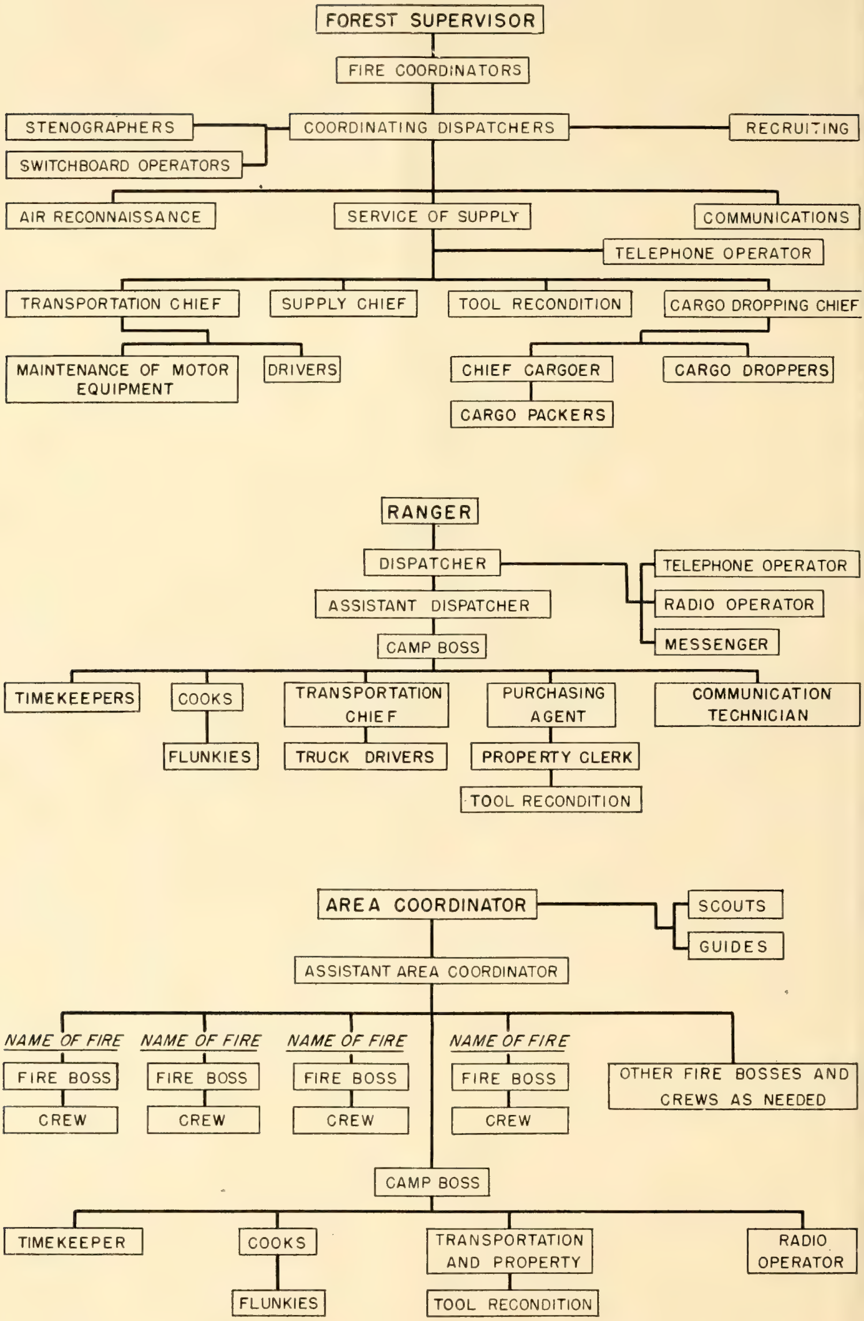
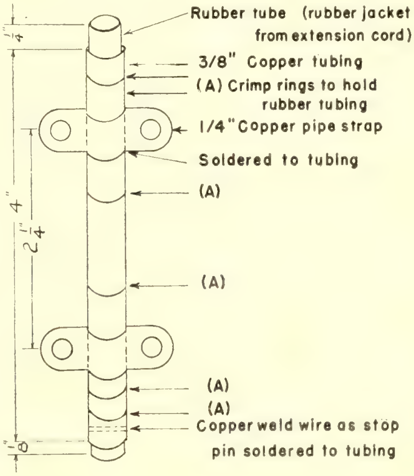


Organization chart for forest supervisor, ranger, and area coordinator.

ice of supply organization. The district headquarters organization furnishes overhead labor and supplies, as requested by each area coordinator. The supervisor's headquarters organization provides the same service of supply to the district headquarters.

The chart indicates the organization which is to handle the maximum fire load. Each division of the organization is built up as the size of the job increases. In other words, the coordinating dispatcher and the warehousemen would probably handle the job for the supervisor, the district dispatcher for the ranger headquarters, and the coordinator with a few fire fighters would handle the beginning of a concentration, directing all of the activities which are indicated under them on the charts. As the needs increase, the organization is gradually built up to keep abreast of the size of the job by adding individuals to handle the various services.

Antenna Safety Holder.—The prescribed method for holding down a whip antenna, by merely placing it under a hook mounted at the rear of the roof on a sedan presents a serious safety hazard to a person's eyes when opening the car trunk.



A simple yet highly efficient solution to the safety problem is shown in the accompanying drawing. The holder consists of a piece of rubber-lined copper tubing attached to the roof of the vehicle by means of sheet-metal screws. The tip of the antenna rod is pushed into this tube and is held in place by the thrust of the steel rod when bent. Since a positive connection is not used, the antenna rod may be pulled out if struck by an overhanging tree limb or other obstruction.

In the case of pickup and stakeside truck installations the tube (without the pipe strap holders) is attached to a chain or thong which, in turn, is fastened to the side of the bed or guard rail of the vehicle.—John H. West, *Forest Engineer*, and Charles E. Bell, *Radio Technician, Six Rivers National Forest*.

WILL EXHAUST GASES HELP PUT OUT FIRES?

T. V. Pearson

Administrative Officer, Forest Service, Washington D. C.

One gallon of ordinary gasoline vaporized at 100° C. (212° F.) occupies a volume of about 195 gallons. About 90 pounds of air (9,000 gallons) is used to burn the vapor from 1 gallon of gasoline, assuming perfect combustion without excess air. Such burning in an average auto engine produces about 96 pounds of exhaust which, cooled to ordinary atmospheric temperature, equals about 1,300 cubic feet (9,750 gallons). This exhaust is composed of 14.8 percent carbon dioxide and 85.2 percent other inert gases, principally nitrogen, all enemies of fire, with only traces of oxygen, carbon monoxide, methane, and hydrogen.

Exhaust gas usually leaves the exhaust pipe at a temperature considerably higher than atmospheric temperature, therefore the volume at the exit may be as much as two to three times as great as the 1,300 cubic feet quoted.

Some simple trials were made in the summer of 1946 to observe the effectiveness of hot exhaust gas in smothering small test fires. The exhaust gas from a small sedan engine burning 1 gallon of gasoline in about 30 minutes registered roughly 500° F. at the exhaust exit. This was applied through a 50-foot flexible metal hose. At the exit of this hose tests showed the temperature to be about 300° F.

1. One quart of gasoline was sprayed on a tree trunk to a height of 6 feet and ignited into a roaring flame. Careful application of the exhaust gas extinguished the flame in about 12 seconds.
2. One quart of gasoline was splashed on the outer wall of a garage and ignited. The roaring flame was extinguished in about 18 seconds by application of the exhaust gas.
3. A teacup of gasoline was poured into a 12-quart bucket and ignited. The flames were smothered by the exhaust gas in 4 seconds.
4. One-half gallon of gasoline was sprinkled on a 10-foot square surface of hard clay soil and ignited. The flames on the full area were extinguished by the exhaust gas in about 20 seconds.
5. An actively burning fire in a pile of kindling wood 2 feet in diameter was extinguished by the exhaust gas in about 35 seconds.
6. A line of fire in dry oak leaves on a forest floor was extinguished by the exhaust gas at a speed of a slow walk.
7. A line of fire burning in 5-inch dry grass was extinguished by the exhaust at a speed of a slow walk.
8. A cup of gasoline was sprinkled on the auto engine and ignited. The exhaust gas extinguished this engine fire in a few seconds.

9. The exhaust gas was applied to a large bonfire with only little effect. Flames in limited sections were extinguished, but following the application of the hot exhaust gas the flammable gases from the wood mass were repeatedly ignited by the heat from nearby hot coals. *The method therefore would fail in heavy fuel because the hot gases do not reduce the temperature of the fuel below its kindling point.*

Thus we have some evidence that hot exhaust gas undiluted with air, or diluted with that amount of cold air which will limit the oxygen content of the mixture to a point below that required to readily support burning (about 11 percent), has a smothering effect that will control fire in some light flash fuels. There is needed, however, a feasible method of cooling the exhaust gas, without increasing the oxygen content beyond the tolerable point, to give it greater control effect on hot fire in heavier fuels. Several methods have presented themselves, including injected water spray as a cooling agent. This will also serve to reduce the temperature of the fuel below its kindling point.

What could be done with an adequate supply of cooled exhaust gas and water vapor produced at the fire location from a few gallons of liquid fuel and water from a baby jet engine is still a question. Such engines having about 20 pounds thrust have just become available. A few field men are becoming interested in the possibilities of this combination and have proposed experimental trials.

Carrying Fire Canteens.—We have all experienced or observed the awkwardness of fire fighters trying to work and carry a 1-gallon canteen at the same time. Three systems of handling canteens are used:

a. They lay the canteens down and work, then come back and pick them up or forget them.

b. Hang them over their shoulders and wrestle with them.

c. Carry them on their backs by using a double sling for their shoulders. Many straps are too short for this system. As the fire fighters work the straps work down; or, if they don't, are too tight and cut beneath the arms.

It is recognized that the high nuisance effect of any piece of personal equipment is a great detractor from efficiency.

Suggested solution—rivet either canvas or leather straps to the flat side of the canteen covering and run a belt through them. The canteen then fits snugly in the small of the back and out of the way. I once used an Army cartridge belt to good effect. I have tried this system and it really works well.—NEAL M. RAHM, *Supervisor, Inyo National Forest.*

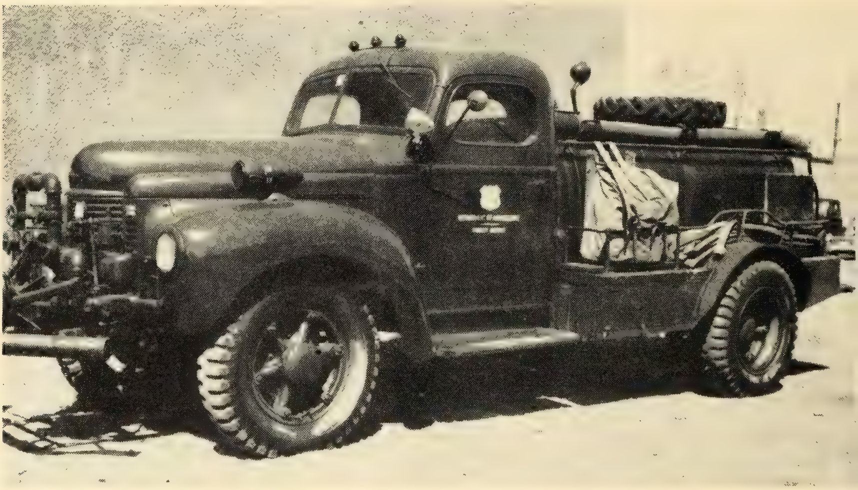
AN ARMY BRUSH TRUCK FOR FOREST FIRES

CHARLES D. SUTTON

General Foreman, Lincoln National Forest

The need of a truck equipped with tank and pump for fire suppression had been evident on the Lincoln National Forest for several years but lack of funds prohibited the purchase of such equipment. A very satisfactory unit was finally purchased for $1,000 from surplus Army equipment at the Hollomon Air Base near Alamogordo, N. Mex.

This unit consists of a 780-gallon tank and American Marsh F400 pump mounted on a K–5 International truck. It had been built in the shop of the post engineer at the air base for use in a range camp and required very few changes to adapt it for use in suppressing forest fires.



The pump is mounted on the front of the truck and driven by the truck engine. A throttle, clutch, and control valves are so arranged that the operator can stand in front of the truck and operate the unit. The pump is so connected that water can be pumped from the tank or from a stream or sump into the tank or directly into the discharge lines. All pipes and connections are 2-inch, and gate valves are so arranged that the operator has complete control from one position.

The suction line consists of two 10-foot lengths of 4-inch suction hose and strainer, and a 2-inch discharge line extends to rear of truck. A 1½-inch siamese connection on discharge line and a 1½-inch discharge

connection on the pump make it possible to operate one, two, or three lines simultaneously should they be desired. A vacuum primer mounted on the pump assures immediate suction when pumping from a stream or sump. The discharge line from the pump is equipped with a ½-inch hose to the radiator to aid in cooling the engine while pumping or going up steep grades when the engine would normally overheat.

In addition to the tank and pump the truck has a box constructed on the rear of each side platform and 200 feet of hose is folded in each box making it possible to lay 400 feet of hose in the shortest possible time. Additional hose is carried on the truck in pack sacks. Two 2½-gallon carbon-tetrachloride and three 2½ gallon soda-acid fire extinguishers are mounted on the rear and side platforms and have proven quite successful in suppressing small fires. In addition to the extinguishers, axes, shovels, electric lanterns, and other items are carried on the truck. Two spot lights and a flood light mounted on the truck and tank are of much value at night. Spanner and pipe wrenches and small tools are carried in the truck making it possible to connect hose quickly and to make minor repairs and adjustments.

After experimenting with different nozzles it was found necessary to have both straight stream and fog nozzles with the truck and both types have proven quite satisfactory on different type fires. It is possible to fill the 780-gallon tank in approximately 2 minutes pumping time and to discharge the 780-gallon tank through two 1½-inch hose with straight stream nozzles in 5 to 6 minutes. Very unusual conditions would exist when water would be discharged at this rate. Normally fog nozzles are used and rate of discharge is held to the minimum for controlling the fire. The working pressure varies from 80 pounds to 150 pounds depending upon conditions and is controlled by the operator using the hand throttle on front of truck.

The first time this piece of equipment was used it made it possible to save a sawmill and planing mill. The shavings pile between mill and planer was on fire when the truck arrived. The water in the tank was sufficient to knock the flames down and prevent spread of the fire until water was turned into a nearby irrigation ditch. Water was then pumped from the ditch directly into the shavings pile and the fire completely extinguished. Since that time the tank truck has been used successfully on many fires in the recreational and summer resort area where it is maintained during the peak of the fire season and has paid for itself many times in property saved and forest fire suppression.

After 2 years of operation we wonder how the situation in this area was controlled without this piece of efficient and effective fire-suppression equipment.

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SURVEYING FOREST SERVICE COMMUNICATION NEEDS

K. W. McNasser

Forester, Jefferson National Forest

As this country developed, the communication facilities expanded to meet the greatly increased demands. Messenger type communication was rapidly supplanted by the telephone and telegraph, and the Nation became increasingly dependent on them for exchanging information.

During the first half of this century the scope of the work of the Forest Service called for a dependable and rapid means of communication. To protect and administer properly the natural resources of the national forests belonging to the people, this agency spanned thousands of miles with telephone line. In many areas the Forest Service systems were the only lines available. Early lines were primarily for protection; administrative use was incidental. Routine administration could ordinarily depend upon slower communication.

Gradually, the primary use of Service lines in some parts of the country turned toward administration; the advances made in protection having somewhat changed the picture. The Civilian Conservation Corps and other agencies had taken care of construction and maintenance during the 1930's. When these agencies ceased to function, maintenance became a problem. Just as the demand brought about an expansion in communication facilities so changing conditions called for reduction in certain types of communication. Commercial companies have moved in and are ready to furnish service to areas hitherto without any communication or dependent on Forest Service lines The time is here to take careful stock of our needs and determine just what we must retain and what we should eliminate. Lines that recent communication plans for administrative units have revealed are no longer needed can be disposed of through sale, salvage, or cooperative agreements with other agencies or private companies.

The increased use of more efficient radio communication has entered very conspicuously into our plannning. Miles of telephone wire and poles, located on miles of right-of-way, present a real problem of maintenance and cost. Radio seems to be one of the means of cutting down this communication expense. But radio is no panacea for communication problems. There still remain sections where wire communication is a necessity.

Radio, as a rule, is not used to reach individual warden crews in rural areas. If commercial wire is not available, then the Forest Service may be faced with the job of handling this situation through its own system. Generally year-round communication is not an abso

lute necessity on Forest Service lines but when these systems tie in with commercial exchanges or otherwise furnish an outlet for rural areas something of an obligation rests on the Forest Service to maintain service.

Radio will often make possible the abandonment of sections of line, leaving other sections isolated with no connection to commercial lines or to Forest Service headquarters. Radio communication to a lookout tower which also has telephone service on the isolated section will open up the entire communication network during the times of the year when the system is most needed for protection. Sections not absolutely needed present an unwarranted cost and cannot be justified. The new type TF frequency-modulated radio designed for use in lookout towers appears to be dependable to the extent that nonjustifiable wire sections can now be eliminated.

A study showed that on some units of the Jefferson National Forest a reduction in telephone mileage of nearly 50 percent will be possible in the next couple of years through communication replanning, commercial service can be purchased or secured through agreement, sections can be abandoned and salvaged or sold, and radio can be used to fill in the missing links.

Communication is no less important than heretofore. The exchange of pertinent information is a necessity on the fire line and in proper administration. However, we must survey the situation carefully to determine just where the needs exist.

A review of action on going forest fires has frequently revealed that communication between the various sectors has been inadequate—to the end that suppression action has suffered. The essential thing is that communication be maintained: the type should be that which best fits the situation. It may be foot messenger, temporary wire, portable radio, combination of portable and fixed station or mobile radio. Adequate communication will tend to prevent the confusion, and sometimes disaster, that results from a lack of knowledge of facts.

The type SF handy-talkie radio is probably the quickest means of establishing communication on a fire. Several of these sets will tie in the fire sectors with the fire boss. Type SF radio direct to a lookout tower having a type TF with its repeater will often give rapid and accurate data to the dispatcher. Sometimes, it may be more effective to clear messages from the fire line through a fire base radio which may be a mobile type KF installed in the ranger's or fire assistant's vehicle. The Jefferson National Forest used FM radio, types TF, SF, KF, and UF, during the spring fire season of 1949. In actual operation this equipment functioned up to or better than our expectations.

FM radio is another link in our communication chain, and it may make possible the elimination of less effective and more-expensive-to-maintain sections. This improved radio is certainly a reason for us to carefully scrutinize our communication set-up.

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PROTECTIVE CASE AND JOINTED ANTENNA FOR FM HANDIE-TALKIE RADIO

W. S. Davis

Forester, Region 2, U. S. Forest Service

The Rocky Mountain Region recently made a test purchase of a small number of Motorola FM handie-talkie radios, intended as a means of communication with radio-equipped fire lookouts by rangers on trips in remote areas during periods of critical fire danger.

In its commercial version, the thin aluminum case and exposed hand set, antenna base, and switch of the radio did not seem to offer the set sufficient protection for rough usage on pack trips, surveys, timber sale work, etc. Therefore, a protective carrying case was devised.

Cases were made by a saddlery shop in Denver at a cost of $22.50 each. Considering the purchase price of the radio, this is cheap protection. Each case is made of double saddle-stitched leather, with inside measurements of 3½ by 10¼ by 12½ inches. The carrying strap, with which the radio comes equipped, snaps into loops on the side of the leather case. The radio fits snugly in this container and is operated in place; removal is necessary only for maintenance or for the replacement of batteries.

The one-piece tapered steel rod antenna furnished with the handie-talkie could not be made to fit in the carrying case, so a substitute had to be devised. The screw socket was fastened to a jointed aluminum rifle cleaning rod, which was then cut to the length required by the transmitting frequency. The disassembled antenna sections are carried in a linen holster held in place by two leather snaps under the lid when the case is closed.

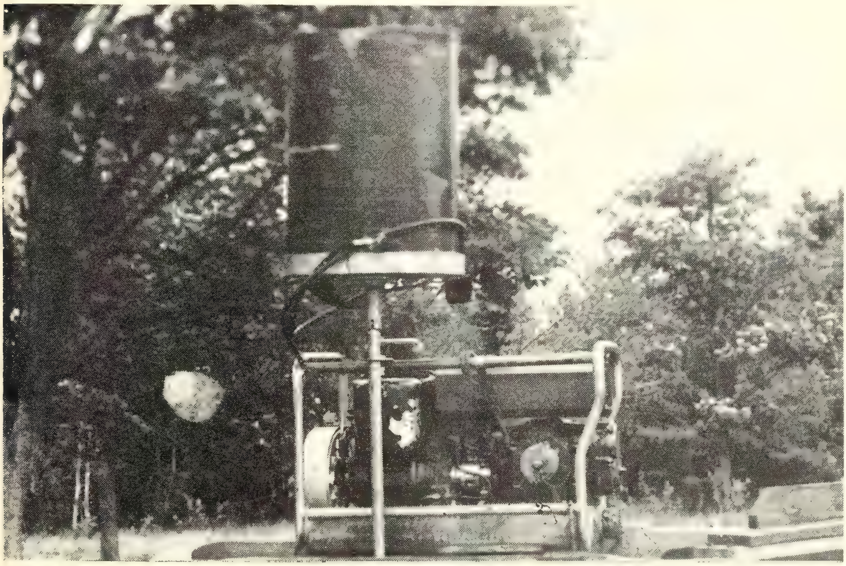
The complete case adds litte bulk to the compact radio, and affords ample protection under practically all travel conditions.

GAS CAN HOLDER FOR PORTABLE PUMPS

Edward Ritter

Forester, Region 7, U. S. Forest Service

How often have you, as a portable pump operator, looked for a limb, tree, post, or pole to hang the gasoline tank on, and found nothing suitable at the critical moment? Well, here is how Horace Remick, a warden for the State of Maine, at Ellsworth (near Bar Harbor) solved the problem. His oval holder may not be an entirely new innovation but its design, I understand, is original.



A piece of ½-inch galvanized water pipe, 23 inches in length, is gound down and tapered to fit snugly but easily into a ¾-inch pipe nipple. The ¾-inch pipe nipple, 4 inches in length, is fitted into a 3½-inch pipe flange. The flange is attached to an oval wooden base by four wood screws.

This base, which is used to support the gas can, was made to order for a special gas can in stock on the district. Three-quarter inch plywood was cut on an oval pattern, 12⅜ inches the long way by 7¾ inches across the narrow side. The periphery was banded with a piece of ⅛-inch strap iron, 1½ inches in width, to hold can in place. A short pin in the ½-inch pipe is fitted into a slot in the ¾-inch nipple to prevent base from turning.

The upright piece of ½-inch pipe is held in place near the top by a guide clamp attached to the cylinder head, rack or protection rail, and its base is inserted in a hole bored into the carrying frame, which is reinforced by a block of 2 inches by 4 inches about 6 inches long.

Total cost for materials would probably be around $3, but salvaged materials or pieces of scrap may be obtained for less.

REFLECTING WARNING SIGNS

E. L. Baxter

Division of Fire Control, Region 5, U. S. Forest Service

Fire crews working on fires along busy highways have not been given adequate protection from fast moving vehicles. This is especially true at night because we have not had effective signs to warn the traveling public of the danger ahead.

Merve Adams, central dispatcher, Shasta National Forest, suggested we provide tank trucks and other vehicles assigned to fire control along roads with warning signs that could be placed on the edge of the roadway on both sides of the fire area and could be readily read day or night.

His suggestion has been accepted, such a sign has been developed and, after checking with numerous sign companies, bids are now circulating for reflecting warning signs. The size and wording of the sign are shown in the diagram. The sign will be on S½ hard .051 aluminum. The background is to be a bright red, the letters are to be silver. The entire sign will be treated with reflecting glass beads. This combination, as proved by numerous tests, gives a sign that is easily read at night by fast moving motorists. Of real importance in such signs is keeping the number of words down to not more than 5 since the driver of a fast moving vehicle can't pick up more than this number before passing the sign.

The sign will be riveted to the top bar of a swivel folding base that is made of two ½-inch pieces of square bar steel. The bottom bar fits inside two short feet at the ends of the top bar and the two are joined in the center by a large rivet that permits them to be opened to form a "+". This is sufficient base to hold the sign upright.

The advantage of this type of sign base over the orthodox type is that two signs will nest in a space a little over 1 inch thick, thus two signs can be fitted almost anywhere in a truck in a light wooden case, whose over-all dimensions are slightly larger than those of the signs.

EVOLUTION OF FIRE LINE PLOW DESIGN IN R–9

Guerdon L. Dimmick

Equipment Coordinator, Division of State & Private Forestry, Region 9, U. S. Forest Service

Two field demonstrations of equipment recently held in Missouri emphasized the progress made in fire line plow design and prompted this review of fire line plow history as it applies to Region 9 of the United States Forest Service.

Prior to the establishment of the Civilian Conservation Corps, fire suppression, and particularly line construction, was largely dependent on hand labor with axes, shovels, and back-pack pumps. Similarly tree planting, including ground preparation, was being done largely by hand labor.

Walking agricultural plows drawn by horses and small agricultural tractors had been used for years, but with the advent of the large CCC planting program there was an urgent need for larger and better plows to provide shallow, clean, wide furrows for planting, and that could be easily moved between jobs.

The CCC camp repair and blacksmith shop facilities and personnel afforded an opportunity for experimental development of suitable plows. In 1934 a 700-pound lister or middlebuster plow was designed and produced, but soon proved to be too light. A larger plow weighing approximately 1,500 pounds was produced in 1935. The larger tractors of the 30-hp. class and up which this plow required in turn presented additional transportation problems. Further study and local experimentation continued.

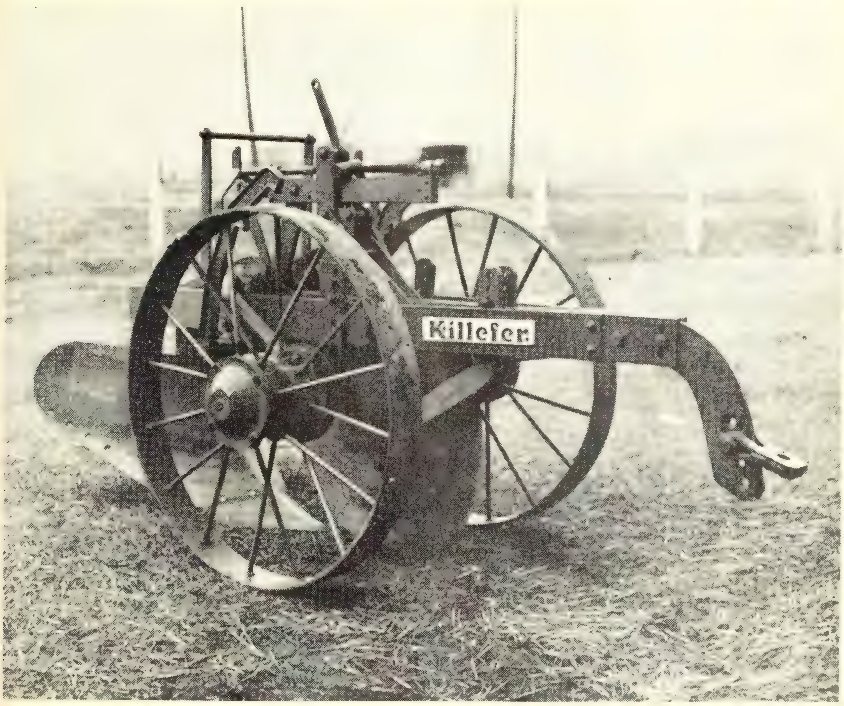
This study resulted in securing for testing a Killefer plow, made by the Killefer Corp. of Los Angeles, Calif., and successfully used as a wheeled ditcher plow in the West. Some changes in the plow bottom were suggested by Mr. Wagler, at that time an equipment sales engineer of Milwaukee, who had kept himself fully informed on the experimental work on plows.

The approval of this plow with the "Wagler" bottom, and the decision of the United States Forest Service to buy a quantity immediately posed a question as to a possible source of supply for such a specialized plow. Numerous contacts with commercial manufacturers developed a common pattern of disinterest due to the limited market for a specially designed agricultural plow. The Killefer Co., however, expressed their interest, and a considerable number of Killefer plows known as model 77 were subsequently built by Killefer as designed by Mr. Wagler and purchased by the Forest Service for the Civilian Conservation Corps program.

Certain limitations in the Killefer plow were found through experience, indicating that heavier plows and heavier tractors were essential.

Two years later (1938) the plans for a radically new plow came from Mr. Wagler's drafting board. They included a special design in moldboard construction which furnished a marked improvement in the type of planting furrow.

The plow, with a 42-inch rolling coulter encased in a heavy steel housing, was designed without a sulky and weighed 2,600 pounds. Because of its weight and nonmobility it was extremely cumbersome and difficult to handle when uncoupled from the tractor; but on furrowing and fire line construction it outperformed all its predecessors



Original ditcher plow purchased from Killefer in 1934.

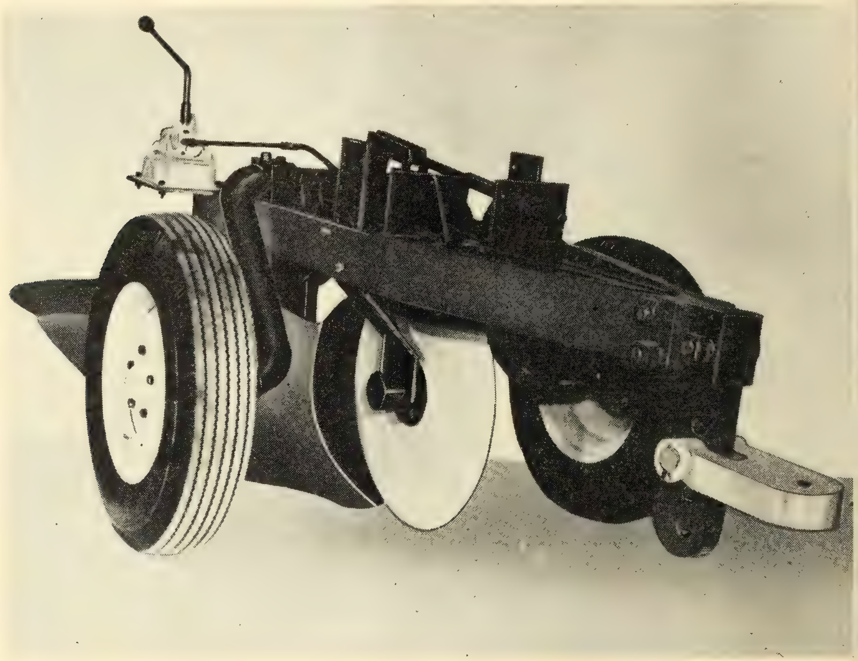
with little or no maintenance. Again the Killefer Corp. was the only commercial manufacturer who would agree to build this plow. It subsequently delivered 57 units known as the Wagler fire line plow to Region 9.

The inactivation of the Civilian Conservation Corps program and the advent of war resulted in much of the CCC equipment, including many tractors, being turned over to the armed services, thereby leaving this latest plow as a surplus item because of its weight and lack of mobility.

The design and production of this type of equipment, drastically curtailed throughout the war years, has experienced a revival in the past 2 years. Neil LeMay, Chief Forest Ranger for Wisconsin, had been favorably impressed by the performance of the Wagler nonmobile plow. He acquired a number of surplus plows, removed the

moldboard assemblies from the original plows and mounted them on specially constructed sulkies. The result is considered to be one of the most satisfactory fire line plows built to date for the types of fuels and ground conditions found in this area. These units, used with 30-hp. crawler tractors, are transported on two-wheeled tilt-bed trailers and constitute the State's best initial attack plow units.

During the spring fire season of 1947 Mr. LeMay was in Missouri to study their radio fire communication system and while there had an opportunity to participate in fire suppression work. After a night



Wagler model 30A plow in present use.

of back-breaking and hand-blistering work fighting fire, he stated that he felt Wisconsin's latest converted Wagler plow would work in Missouri and offered to demonstrate it by bringing a tractor plow unit to Missouri on a tilt-bed trailer.

As the result of the subsequent request of Missouri State Forester White, Wisconsin put on a plow demonstration for State and Federal representatives at Sullivan, Mo., in the spring of 1948. Wisconsin's converted Wagler plow fulfilled the expectations of the sponsors to the satisfaction of the fire technicians present.

The United States Forest Service and Missouri both wished to acquire similar plows. The revival of interest again presented the familiar problem of where to get this type of plow. Killefer Corp. had been sold and the facilities of their successors were closed to production of experimental models for outsiders. Other possible sources were more restrictive than before the war. This problem was solved by the Wagler Equipment Co. whose new factory at Pewaukee, Wis.,

was dedicated to the production of specially built equipment for forest use by National, State, and private agencies.

The first Wagler heavy-duty, mobile fire plow was produced in 1948 and taken to Wisconsin State Fire Headquarters at Tomahawk for a comparative test with the Wisconsin converted plow before a group of State and Federal fire technicians. After the test definite suggestions concerning possible improvements or changes were obtained from the group.

The final approved model incorporating the suggested improvements was completed in November 1948 and taken to Missouri for its final demonstration before 70 State and Federal representatives under carefully selected conditions that would thoroughly develop any possible limitations.

The plow's performance won the unanimous approval of the group, and units were purchased by the United States Forest Service and the State of Missouri. The State of Minnesota was also impressed by the possibilities of this unit and has purchased 15 for fire suppression work in that State.

Some of the features that merited favorable comment at the Missouri demonstrations are as follows:

1. The trim appearance, simplicity in design, and rugged construction around a 3-inch axle of unique design.
2. Its extreme portability and roadability at high speeds due to its low center of gravity, perfect balance, automotive type wheels, pneumatic tires, and high speed axles.
3. Its 34-inch wide lister or middlebuster type moldboard assembly equipped with easily replaceable agricultural type shares and moldboards mounted on specially designed permanent boards, heavily cross-braced to withstand great compression loads.
4. The elimination of side bracing for the brackets of the bronze-bushed, 30-inch, rolling coulter which can be adjusted to conditions of terrain.
5. The effective screw type depth adjustment with integral locking device for adjustments from transport position to a 10-inch plowing depth.
6. Simple, sturdy, well-located, hand-operated, hydraulic lifting mechanism.
7. Sturdy tractor hitch attached to frame readily adjustable to various tractor drawbar heights.

The Wagler plow although weighing 2,080 pounds was transported by passenger car with a rigid bumper hitch from Milwaukee, Wis., to Sullivan, Mo., a distance of 497 miles, at an average rate of more than 40 miles per hour without any difficulty.

This high speed portability of the fire line plow is of particular interest to fire control personnel as it permits a greater flexibility in the use of fire equipment, especially where policy precludes the exclusive assignment of equipment for fire suppression purposes as in the national forests. Under such a policy trucks, trailers, and tractors would be released for other work.

Further information and specification will be furnished upon request by the Regional Forester, United States Forest Service, Madison Building, Milwaukee 3, Wis.

THE PLUMAS MACHINERY TRAILER

M. D. Stowell

Fire Control Staff Officer, Plumas National Forest

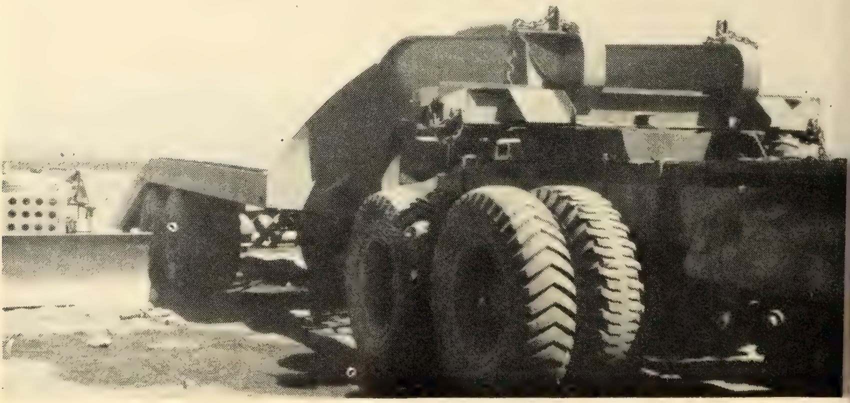
Experienced fire men know the value of heavy bulldozer equipment on slash, timber, and brush fires in the West. It has been estimated that one D–8 bulldozer, properly operated on such fires, is equivalent to 50 good men in constructing fire line.

This Forest has used mechanized equipment on fire line construction for some time. Our problem has been in getting such equipment to fires in time to be of value in line construction. For years, the Forest had a light dozer and transport on fire standby during the fire season, but the transport was slow and the dozer, because of weight limitations of the transport, was not large enough to do some of the heavy work desired on fire line construction.

There are some 20 logging operations on this Forest, all of which have one or more D–7 or D–8 dozers or their equivalent. Operators are willing to use their equipment on fires when needed, but only a few have transports.

It was recognized that these logging operations had logging trucks, the tractor units varying from 140 to 250 horsepower. These tractor units are powerful enough to furnish motive power for a trailer transport to haul large dozers.

There are several commercially manufactured machinery trailers on the market but each of them had some drawback when tried for hauling fire equipment on back-country roads.



View of detailed hookup on log bunk or tractor unit of logging truck.

A survey of the few machinery trailers in use in this area brought to light a trailer designed, built, and used for 7 years by the Graeagle Lumber Co., Graeagle, Calif., which seemed to fit our needs more closely than any commercial or surplus unit.

The main features of this trailer are as follows:

1. It is quickly and easily attached to the log bunk of the tractor unit of a logging truck.
2. Dozers can be quickly loaded and unloaded on any road without using planks or a bank or ramp.
3. It is possible to rent a tractor unit to furnish power for the trailer only when needed, and to get one with sufficient power to haul a D–8 with dozer blade and double drum winch at speeds commensurate with road conditions.
4. The unit can be maneuvered like any semitrailer unit.

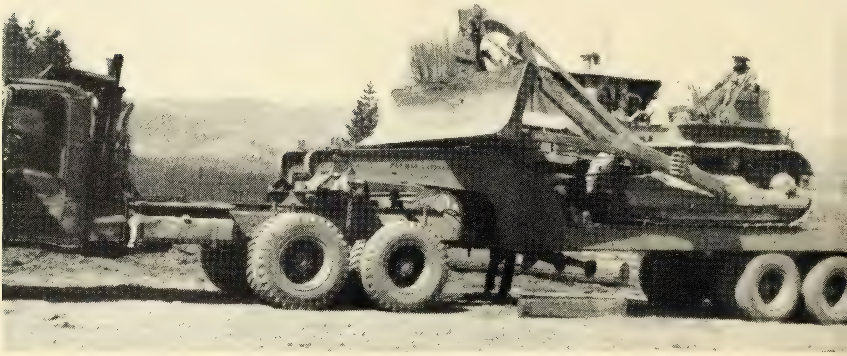
A D–8 dozer being loaded on trailer from a level site. Some blocking is necessary to raise blade and tracks to start up ramp. A folding metal ramp is being fabricated to replace blocks.

It was decided to build a similar trailer unit as an experiment to answer the need for a trailer-transport and to dispense with the standby dozer and costly transport. Accurate costs were kept on the construction of this trailer to determine the feasibility of constructing others to replace standby transports in areas where logging trucks and dozers are available through private concerns but transports are not.

Bids were let for a trunnion type, dual-axled, 8-wheel logging trailer under gear, with a conservative loading potential of 50,000 pounds

for each axle. The unit purchased was equipped with air brakes 10.00 x 20 wheels, coil spring suspension, and cost $1,828.69 delivered

Steel I beams and channels, plates, welding rod, etc., on bid cos $579.84. Twelve-ply tires, tubes, clearance lights and air brake con trols cost an additional $608.62. Labor for 25 man-days cost $314.50 making the total cost to the Forest for this trailer $3,331.65. Thi amounted to approximately 2-years' rental cost for the standby doze and transport. It is estimated that the trailer will be serviceable fo at least 10 years with very little maintenance. Over that period ther will be a considerable saving of public funds.



Side view of truck and trailer with D–8 dozer in final loaded position.

The trailer was constructed in our forest shops by Welder E. J Kessler in 1948. Equipment for such construction was inadequate but through the interest and ingenuity of Welder Kessler the unit wa constructed in a minimum of time.

Initial tests on highway hauling were made in the spring of 194 A 140-horsepower logging truck tractor unit was used for motiv power and the pay load was a 28-ton D–8 with dozer blade and winc This load was hauled 12 miles. The unit traveled up 7-percent grade at 8 m. p. h., on the level at 15 to 20 m. p. h., and down grades at saf speeds of up to 28 m. p. h. with this load. The dozer rode well, th trailer tracked and handled perfectly, and the moving operation wa carried on in a minimum of time. Loading the trailer on the tract unit requires about 15 minutes. Loading the dozer and securing with blocks and load binders requires 15 to 20 minutes and unloadin about 10 minutes. When the trailer is empty the truck travels 40 m. p. h. on standard highways.

The entire trailer is 33 feet long, the bed is 53 inches high and inches wide. It weighs approximately 12,500 pounds.

This trailer is one of several that could function in the capacity i tended. It is not recommended that these trailers be built in a fore shop as the steel used in its construction is too heavy to be handled the light equipment usually available.

OLIVER TRACTOR-TANKER-PLOW UNIT

EINAR E. AAMODT

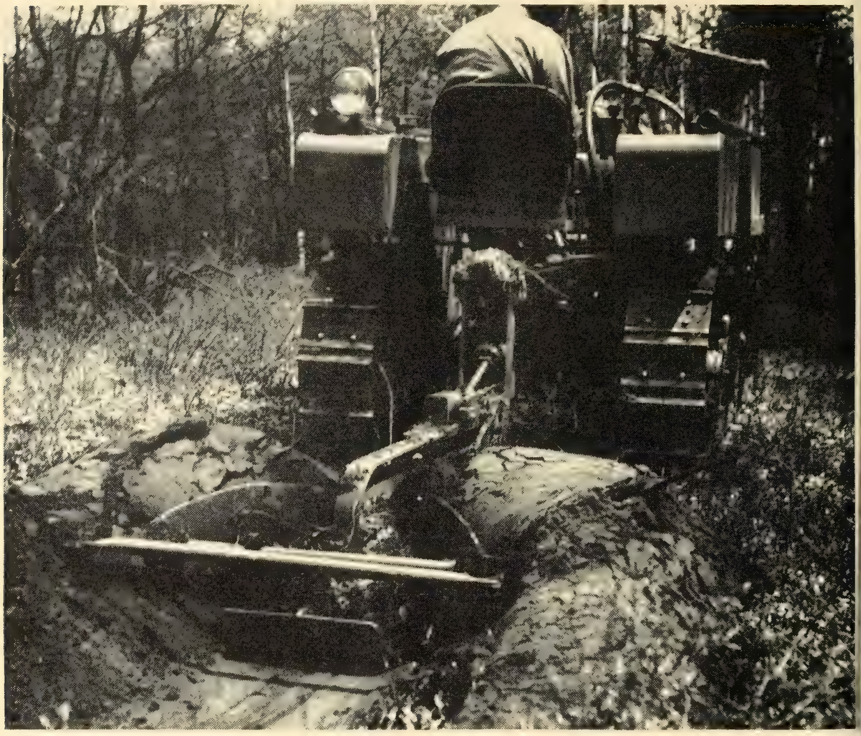
Engineer, Roscommon Equipment Development Center, Region 9, U. S. Forest Service

A new fire-fighting tool, a tractor-tanker-plow unit which is almost n a class by itself, has been developed around a new H. G. Oliver ractor. The initial demonstrations and tests of this unit proved it to e very satisfactory. The tractor is equipped with two 45-gallon tanks, Porto pump with chain drive from the main drive shaft and a hand-perated clutch to engage the pump unit, a hydraulic lift control unit nd stubby plow, a pusher bumper, and a nozzle gun support. It is ightweight (about 5,400 pounds loaded with water) and can be hauled asily on stake trucks or a light R–8 tilt-top trailer. It is fast on asy, open going; and in heavy going it can build a good line under lmost any condition. Its small size permits getting around and hrough places where larger plow units have trouble. There is no lost ime due to hang ups, and under the toughest conditions the plow does ot clog up. The unit can be used for mop-up with the tanker or as a tationary pump using 1½-inch hose.

The pusher bumper, a hydraulic-controlled short-width dozer, is ery useful in mop-up, and to clear out logs and slash or debris in line onstruction. The hydraulic control unit on the plow is also a decided dvantage and improvement. The plow can be quickly raised or low-red while the tractor is standing or in motion. It is possible to put

'ractor-tanker-plow unit, showing water tank over crawler track, nozzle gun on swivel support, and hydraulic-controlled bumper dozer.

800 to 1,000 pounds pressure on the plow, in fact enough to raise the rear end of the tractor off the ground. The dozer and plow can be raised or lowered together or each unit operated independently. The plow is a standard straight coulter stubby plow with standard 14-inch plow bottoms and a reinforced hitch. A heavy spring loading arrangement is used on the plow to allow it to slide over large rocks or stumps to prevent damage to the plow. The downward pressure on the plow



Tractor-tanker-plow unit with a hydraulic-controlled plow in operation.

is through this spring and the pressure can be varied instantly by manipulation of the hydraulic control lever.

Two water tanks, each of 45-gallon capacity, are mounted directly to each crawler track. There are advantages in mounting the tanks to the tracks rather than to the frame of the tractors. The cost of this mounting is less and the work required is also less. Overload springs are not required, the water weight is distributed equally to each track which gives better traction. The tanks are mounted low and close to the tracks, which is important from a safety standpoint when the unit is traversing steep hillsides and slopes. A flexible hose from each tank is run through a slotted hole in each fender to the pump unit which is located in the center of the tractor above the transmission and just ahead of the operator. The tanks are constructed of 16-gauge sheet iron and are welded over a ¼ by 1 by 1-inch angle iron frame into a one-piece unit. They are heavily coated with Neutral, and have removable covers and filter caps. By removing the covers the tanks

can be cleaned out or coated again with Neutral. The tanks and mountings showed no weaknesses after vigorous tests.

The bronze case model Porto pump has rubber impellers and can pump dirty and muddy water without damage. The pump runs at the same speed as the engine and is driven by a simple roller chain drive off the rear of the clutch housing. A jaw type clutch is used to engage the pump, and the handle is within easy reach of the operator. An adjustable water-pressure by-pass valve is also located within easy reach of the operator. Pressures can be varied up to 220 pounds. An operating pressure of about 150 pounds was found to give the best results with a Hardie gun nozzle, using a 10/64-inch tip and discharging about 8 gallons per minute. The tractor carries suction hose and strainer mounted in clips, and these can be easily and quickly removed or replaced. The tractor can be driven to a nearby source of water for refilling the tanks. The Hardie nozzle is mounted on a two-way swivel so the gun can be directed in any direction or locked in any position. The gun can be easily detached from the holder. On the swivel, the gun can be handled with one hand and it remains fixed in any position as soon as the operator lets go. This allows the operator time to manage the other controls and to steer the tractor. On initial attack the water is primarily used to knock down the hot spots.

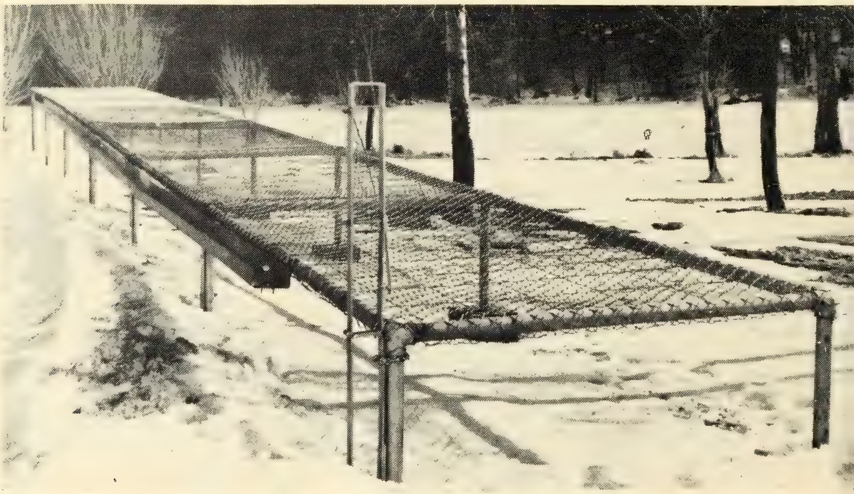
HOSE WASHING AND DRYING RACK

NEIL LEMAY

Chief Forest Ranger, Wisconsin Conservation Department

An effective and durable steel rack for washing and drying hose has been in use at the Rhinelander Ranger Station.

The rack is constructed of 2-inch galvanized pipe and has over-all dimensions of 60 by 6 feet, with a slope of 2 feet in the total length. The uprights may be bent at an angle of 2° to accommodate the slope. However, the Rhinelander rack has regular **T**'s on the side connections and the uprights are welded to the **T**'s at a 2° angle.



Hose washing and drying rack with rewind trough and portable hose winder, at Rhinelander Ranger Station, Rhinelander, Wis.

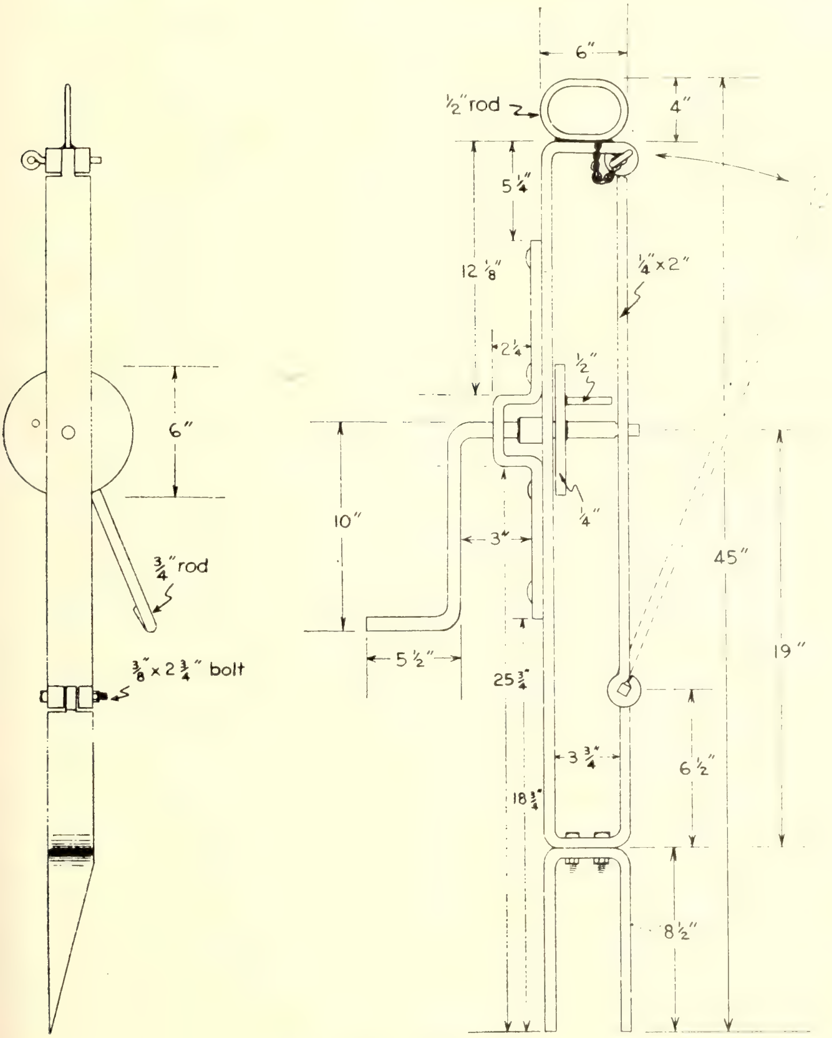
The galvanized wire mesh covering the rack is warped over the edge of the frame and fastened by using No. 9 wire, 1-foot spacing, and then twisting up the wire to pull the mesh into a taut position. The end sections have such wiring in both directions to hold both the ends and sides of the wire mesh. There is some sag but not sufficient to warrant turnbuckles.

The rewind trough is a more recent addition to the rack and is made of sections of two pieces of 3- by $\frac{3}{32}$-inch angle iron bolted together and supported by 2- by $\frac{1}{4}$-inch brackets bolted to the uprights.

One of our standard portable hose winders has been fastened to the end of the drying rack opposite the rewind trough, and it has been found to be a quick and effective means of rewinding the hose after it has been washed and dried. The plan of this winder shows the

sharpened foot only 8½ inches long; this base has been lengthened for attachment to the rack.

The steel rack with its concrete footings has proved extremely durable and the wire mesh has facilitated rapid drying of the hose. Wooden structures are bulkier and are in constant need of painting and repair.



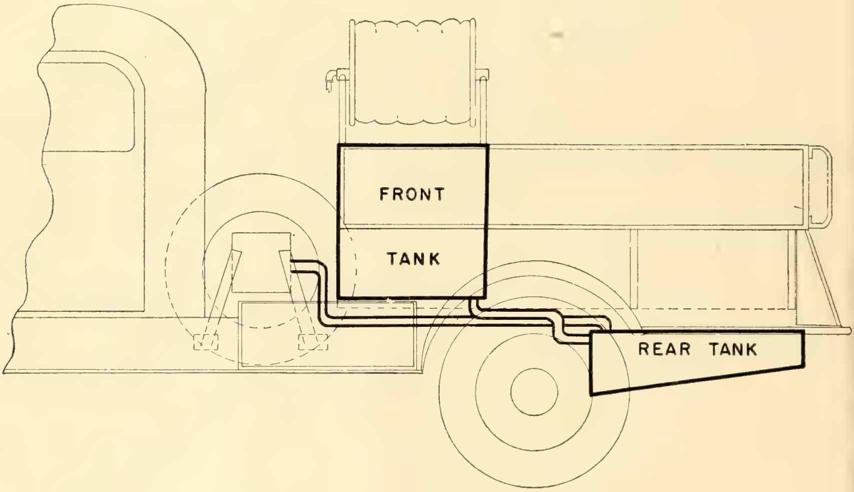
Portable hose winder.

CORRECTING LOAD DISTRIBUTION ON TANK AND CREW TRUCKS

DeWitt Nelson

State Forester, California Division of Forestry

The California Division of Forestry, like most other suppression organizations, has always experienced difficulty in maintaining proper load distribution on combination tank and crew trucks. To a large degree this is due to our policy of carrying personnel at the rear of the truck, thus throwing the water and pump weight toward the front axle.



Position of tank installations for combination tank and crew truck.

We believe that we have overcome this problem to a satisfactory degree by adopting the use of a rear tank suspended from the frame back of the rear axle. For our particular designed truck we are using a tank with a capacity of 53 gallons, constructed of $\frac{3}{16}$-inch plate with cross baffles and cover of 10-gage iron. The unit is 12 inches deep at the front, 6 inches at the rear, 38 inches long and 36 inches wide. There are two $\frac{1}{2}$- by 2-inch pieces of flat iron welded full height of tank on each side, 4 inches from each end; these brackets extend above the tank to the height of the frame to which they are bolted with $2\frac{3}{8}$-inch bolts in each carrier. The entire completed unit is hot-dip galvanized before being installed.

Water is supplied by gravity from main tank by means of a pipe one-half inch larger in diameter than the filler line from the pump discharge into the main tank. The suction line from the lower tank to the pump is regulated according to the capacity of the pump. We also have an air vent from the rear tank back into the main tank.

The tank is installed 10 inches back of the differential center line and has a ground clearance of 15½ inches at that point against 9½ inches at the differential; the least clearance of the tank is at the extreme rear where it is 42 percent of the overhang.

The total weight of this unit is 9,850 pounds without personnel, with a weight distribution of 68 percent on rear axle and 32 percent on front; with a full complement of eight men, the load distribution is 76 percent rear and 24 percent front.

The drawing illustrates the general arrangement of the last 68 units we put in service during the past fire season.

CONVERTING A STANDARD JEEP INTO A MOBILE FOREST FIRE FIGHTING UNIT

D. A. ANDERSON and E. F. EVANS [1]

This article briefly describes the result of the pioneering work of the State of Texas in developing the jeep and accessories for fire suppression work. Further development is now being sponsored by the Lake States and Region 9 of the United States Forest Service with the objective of perfecting well-balanced and standardized outfits that can be mass produced at lower cost. Principal manufacturers of the vehicle and accessories are cooperating in this project.—*Ed.*

A standard jeep requires a number of modifications to convert it into a forest fire fighting unit. Much of this transformation is for the primary purpose of reinforcing the body and chassis to withstand the heavy duty required on the fire line. The factory-equipped jeep filled with gasoline and oil weighs 2,220 pounds. A jeep forest fire fighting unit, as modified by the Texas Forest Service, weighs approximately 3,550 pounds and costs approximately $2,899 as indicated in the following tabulations.

	Weight in pounds
Jeep, factory equipped with full tank of gas and oil	2, 220
Shop-built plow and mountings	300
Extra tools	25
Radio, accessories, and radio box (estimated)	100
Steel top	268
Lift	152
Winch	152
Front grill, front and rear bumpers, frame reinforcement, and miscellaneous	333
Total	3, 550

	Estimated cost	
	Single units (dollars)	*In quantity (dollars)*
Jeeps, less tops, with dual adapters, tires, and wheels for placing dual wheels on jeeps (one unit); tire size 700 x 1 5	1, 445	1, 245
Special design body unit, 13- to 18-gage metal	150	120
Special design plow, grills, belly plate, and painting	125	90
Coulter, 18-inch, rolling	9	9
Koenig winch	250	225
Farm-Aid lift with "Power Pack" hydraulic mechanism	250	225
Radio, FM, 250-watt, transmitter and receiver	575	450
Metal special design radio box	25	23
Back-pack fire pump, 5-gallon, complete	25	23
Special design backfire torch	15	10
Miscellaneous extra repair tools, including wrenches, etc.	30	25
Total	2, 899	2, 445

[1] Respectively, Head, Research and Education Department, and Acting Chief, Education Section, Texas Forest Service, A. & M. College System, College Station, Tex.

Body.—The canvas top is replaced with a 16-gage metal top. Supporting this metal top is a frame made of 1-inch angle iron three-sixteenths inch thick. Stiffeners made of 16-gage metal extend the full length of the top on the interior side. Three metal datum holders are built into the roof near the driver's seat and a tool box is built at the right rear. Canvas doors are used on each side of the jeep.

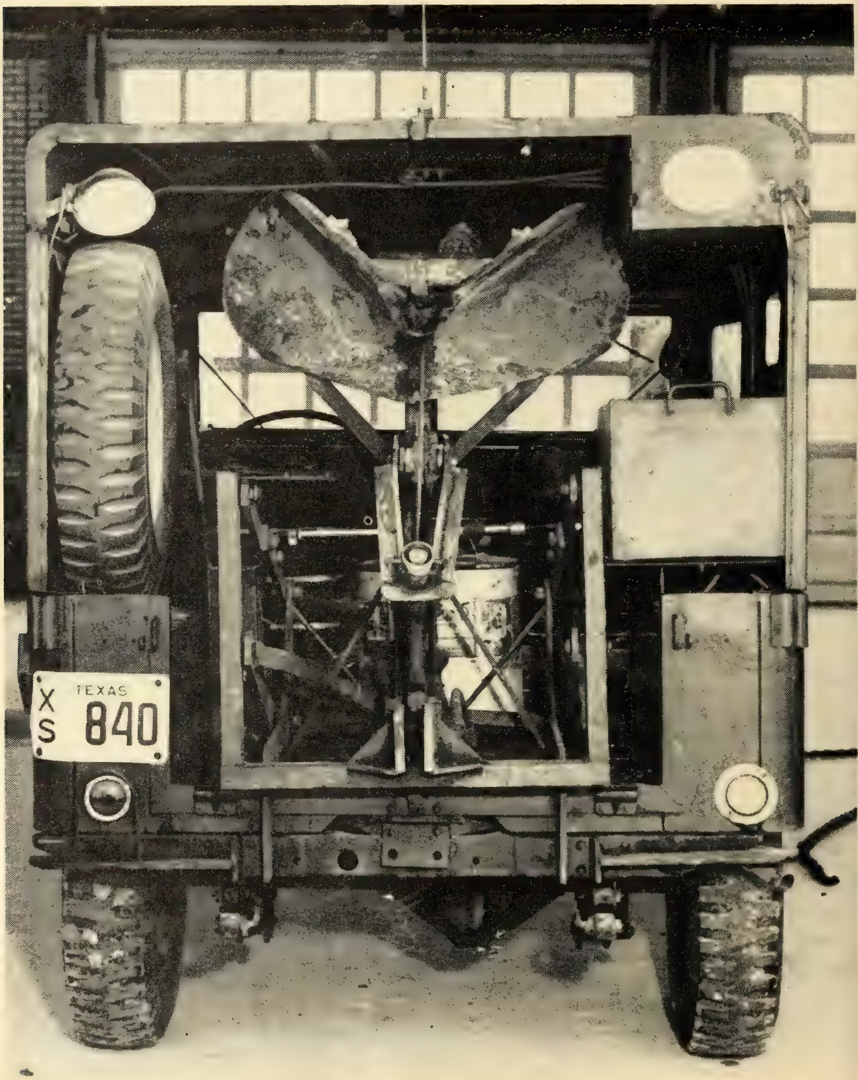
Protection of undercarriage.—Protection for the lower side of the jeep is afforded by three belly plates. One plate, of metal one-fourth inch thick, extends from the front bumper to the radius rods. One additional small plate of 12-gage metal protects the speedometer housing. Another small plate of the same material protects the emergency brake drums. Fenders are reinforced with flat iron one-fourth inch thick by 1 inch wide.

Front grill.—A front grill, made from pieces of flat iron three-eighths inch thick by 1 inch wide, protects the radiator and engine on the fire line. The grill has, at each end, a slanting flat iron brace of the same dimensions. This type of grill and the type made of ¾-inch black iron pipe are used on Texas Forest Service jeep units. The grill is welded to an auxiliary front bumper which consists of a 2½-inch black pipe. This adapted bumper extends slightly beyond

Texas Forest Service fire fighting jeep showing protective grill and winch.

the outer edge of the wheels to give added protection to the tires. The tubular bumper is attached to two pieces of flat iron which are bolted to the original bumper near its end. There are two rear bumpers constructed from pieces of metal 4 inches wide by one-half inch thick.

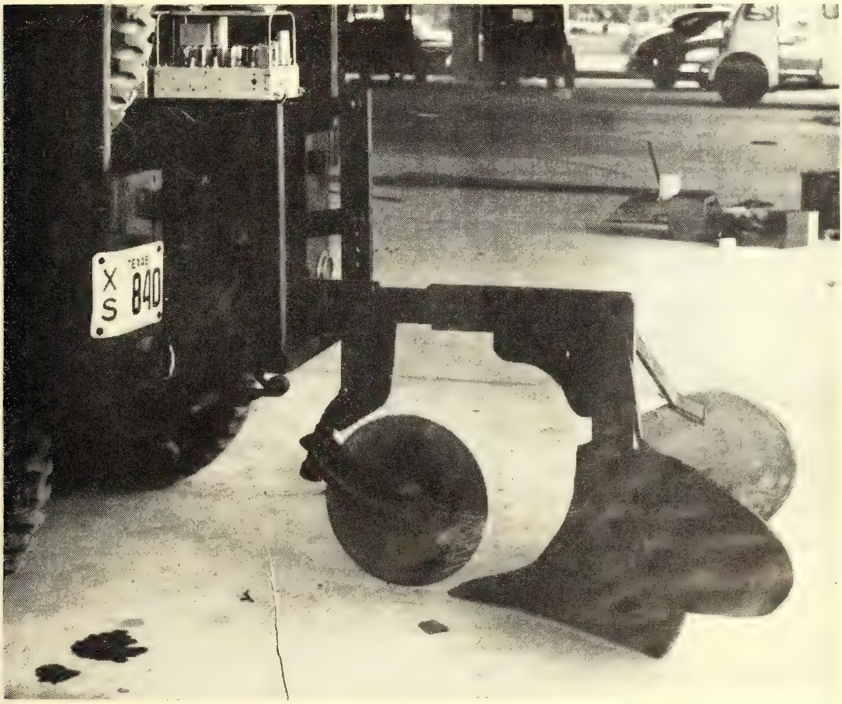
The front end of the frame is reinforced with an L-shaped metal member extending from the bumper to the rear of the front shock absorber. This reinforcing member is bolted at front and rear and welded every other inch. Weight of the front grill, front and rear bumpers, and frame reinforcement is approximately 308 pounds. Heavy duty springs are used on the modified jeep.



Texas Forest Service fire fighting jeep, showing retracted fire plow, spare tire, back-pack water pump, spotlight, and enclosed radio.

Winch unit.—A Koenig one-way winch is bolted to the standard bumper. The winch operates from the engine drive shaft. Gear ratio between winch drum and engine is 72 to 1. Gear ratio within the winch is 36 to 1. Attached to the winch is a 3/8-inch cable 150 feet long with hook. Safe working load of the winch is 2,500 pounds, although the winch is tested up to 9,860 pounds. A chain 25 feet long is used with the winch cable for off-center pulling. This chain is equipped with a quick release attachment for disconnecting the chain while cable is taut. Use of the chain reduces the risk of upsetting the jeep when the pull of the cable is not in a straight line. The winch with complete installation weighs 126 pounds. The cable with hook weighs 26 pounds. A bottom roller has been added to the winch cable guide.

Plow unit.—A middlebuster type plow is used with the jeep unit. The shares are at present made of grader blades and hard surfaced. Each plow share has a length of 23½ inches, and the distance between the rear points of the shares is 23½ inches. The plow shares are approximately one-half inch thick. The plow wings have a span of 34 inches. The plow point is one-fourth inch below the share when the share is flat on the ground. Two pieces of flat iron reinforce the wings. A flat iron brace extends from each wing to the plow beam. The plow is designed to run a minimum depth, and furrows are plowed as shallow as possible. Width of the furrow depends somewhat on depth of plowing.



Texas Forest Service fire fighting jeep, showing coulter and fire plow in position for constructing fire lines and radio with protective cover removed.

The U-frame for the plow is made of 3-inch channel iron on the uprights and 4-inch channel iron on the bottom. A flat plate has been added to make a hollow rectangular member. The U-frame is attached to the four arms of the Farm-Aid hydraulic lift, and has a level adjusting crank. The plow beam is $1\frac{1}{4}$ by 3 inches. It is attached to the bottom center section of the U-frame by two bolts, one of which is removable to permit folding of plow into jeep. When lifted to traveling position the plow fits into a carrying rack. A bolt on the carrying rack locks the plow in traveling position. The same bolt is used to lock the plow in plowing position. This bolt is machined for a tight fit in both positions. The L-shaped plow beam is reinforced at the right angle.

The upright shaft of the 16-inch rolling coulter is attached to the plow beam. A piece of metal reinforces the coulter shaft. The coulter is $1\frac{1}{2}$ inches from the point of the plow.

Hydraulic lift.—The Farm-Aid hydraulic lift is powered by a pump driven by a crankshaft pulley. Another pulley drives the generator, water pump, and fan. Two gallons of SAE engine oil are used in the reservoir of the hydraulic pump, The hydraulic lift used in the Texas Forest Service jeep unit is the single-action type. The single-action hydraulic lift permits the coulter to jump roots and other objects which it cannot cut, thus allowing the plow to jump over the objects instead of hooking under them. The hydraulic cylinder ram has a spin down (jam nut) depth adjuster which permits adjustment of the plow in the event of hydraulic failure. A covering of old inner tube is used to keep dust out of the cylinder system of the hydraulic lift.

To facilitate the plowing of fire lines at night, a light is attached at the upper left rear corner of the jeep top. This light has a separate switch on the dashboard.

Radio.—Radio equipment is an important feature of the jeep unit. Each jeep is equipped with a 50-watt two-way mobile unit with dual channel transmitter.

The receiver has a single frequency of 31.3 megacycles. The transmitter has a dual frequency of 31.3 and 31.42 megacycles. A rooftop antenna is used. The jeep top has a 12-inch square, 16-gage reinforcing plate under the antenna. Receiving and transmitting radius of the jeep unit is 60 miles when communicating with fixed station antennae that have a height of 150 feet. Radio equipment is shock mounted on radiator hose. The cover of the radio equipment is 16-gage metal.

Wheels.—Dual wheels are used in the operation of the jeeps in low swampy land. The 7.00 x 15 wheels are equipped with military grip or studded grip tires.

Color of jeep.—Luzon red is the standard color of the jeep units.

Jeep operation.—The jeep pulls the fire plow in first or second gear in low range. Most vehicles are equipped with factory-installed Monarch or King Seely governors. The speed is adjustable. Plows are pulled at a motor temperature of about 180 degrees with governor and about 195 degrees without governor.

[Further detailed information, such as sources of supply, regarding the accessories described above may be obtained by writing the Director, Texas Forest Service, College Station, Tex.]

ume 11 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

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Forest Service, Washington, D. C.

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Contents

THE HUDSON BAY HIGH AND THE SPRING FIRE SEASON IN THE LAKE STATES

Mark J. Schroeder

Fire Weather Official, U. S. Weather Bureau

INTRODUCTION

What causes periods of critical burning conditions in the Lake States? Are these critical periods associated with any particular weather types? If so, what weather types are generally associated with critical periods in the spring? In the summer? In the fall? The answers to these questions would be of considerable help to a fire-weather forecaster in the Lake States, especially in attempting to arrive at a longer range forecast of impending critical burning conditions.

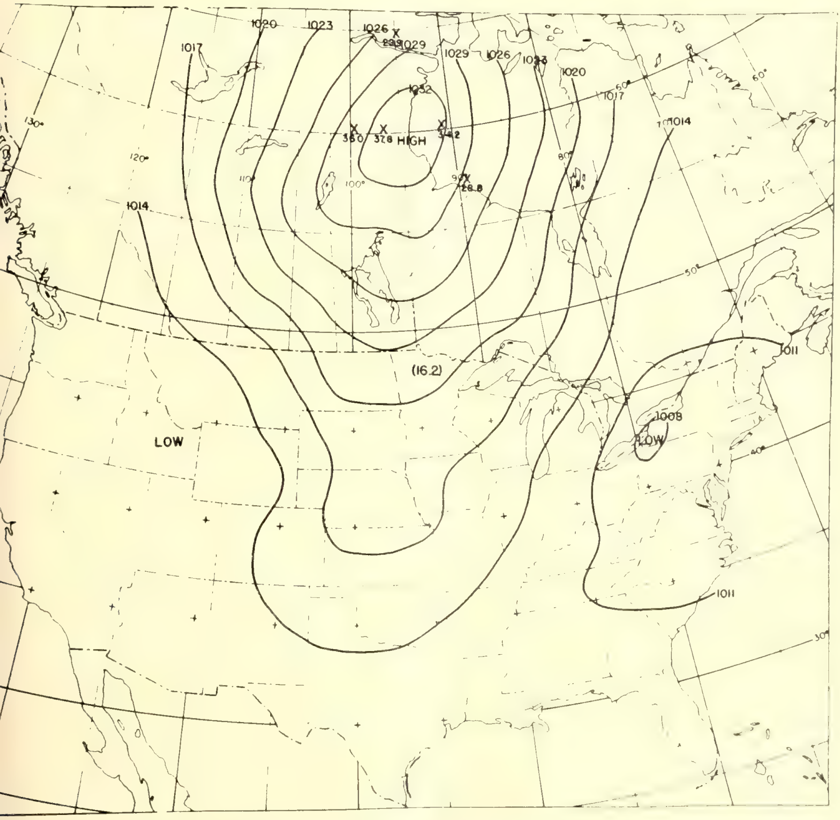


FIGURE 1.—Composite map of the Minnesota cases 2 days prior to the first day of very high burning index. The 6:30 a. m. maps for May 2 and 16, 1946, May 7, 1947, and May 7 and 22, 1948, were used. The location and central pressures of the individual highs are indicated.

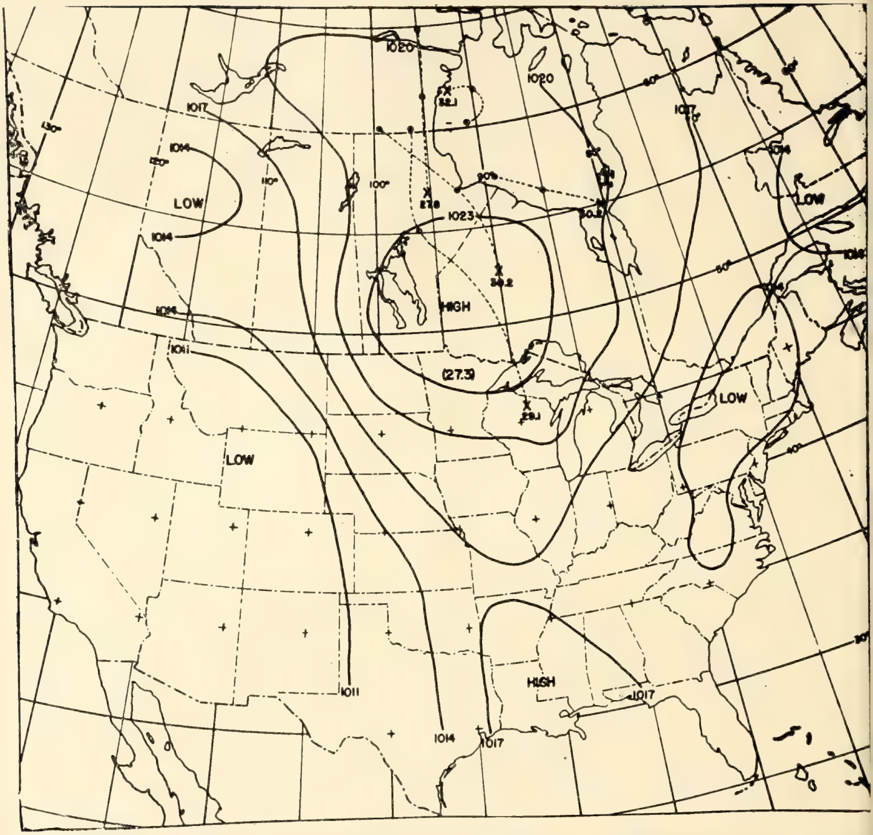


FIGURE 2.—Composite map of the Minnesota cases on the first day of very high burning index. Past daily positions of the individual highs are shown by dots and their paths by dashed lines.

Not all of the above questions are answered here. In this study an examination of the spring burning index records and associated weather was undertaken. It is expected that studies of the summer and fall seasons will be made at a later date.

METHOD

In the Lake States a 0–100 scale of burning index is used which is divided as follows:

safe	0–1
very low	2–3
low	4–6
moderate	7–12
high	13–24
very high	25–49
extreme	50–100

The periods of critical burning conditions for each State were determined by simply averaging the highest burning index reported each day by each of the fire-weather stations. This was done for the spring fire seasons of the years 1945–48. A State average of more than 24 (very high) was considered critical.

The spring fire season in the Lake States normally extends from the 1st of April through the 31st of May. Since only one period of very

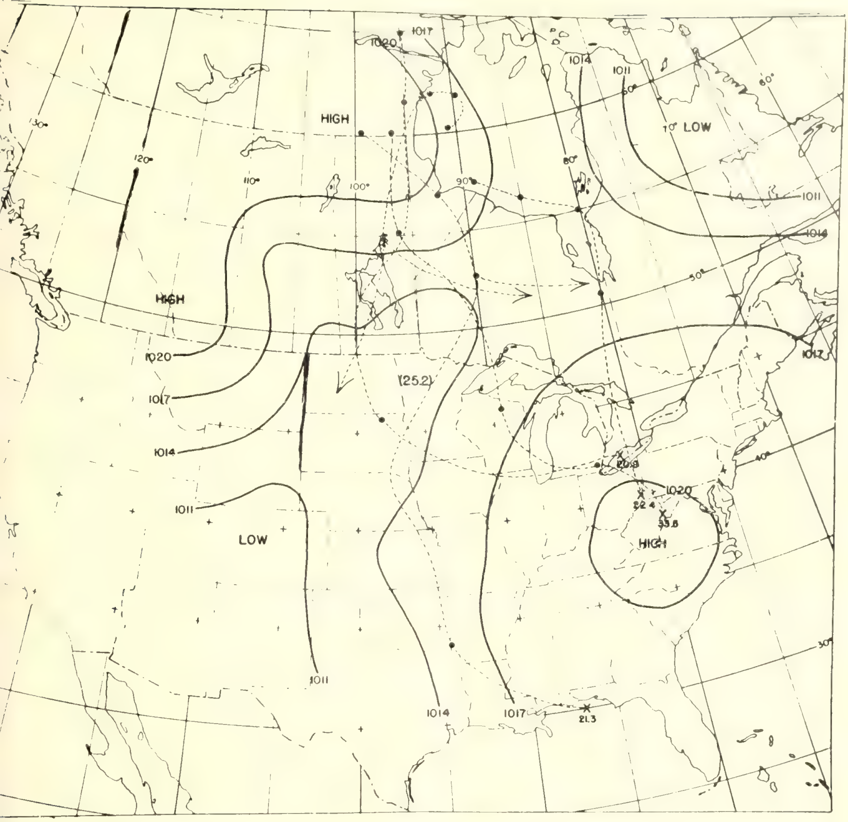


FIGURE 3.—Composite map of the Minnesota cases 2 days after the first day of very high burning index. Paths and daily positions are shown as in figure 2.

high burning index occurred during the month of April, not justifying a study of weather types, only the month of May was considered further. There were five May periods of very high burning index in Minnesota, eight in Wisconsin, six in Upper Michigan, and four in Lower Michigan.

A study of the weather maps during these critical periods showed a similarity between most of the weather situations. To bring out this similarity, composite maps of the similar cases were made by averaging the sea-level pressures at each of a large number of weather stations in the United States and Canada and drawing isobars (lines through points of equal pressure) for these average pressures.

DISCUSSION OF RESULTS

Nearly all of the critical periods were associated with an area of high pressure (hereafter called a "high") which developed near the western shore of Hudson Bay and subsequently moved either southward or southeastward. A slow-moving high that develops or intensifies in the Hudson Bay region is frequently referred to as a "Hudson Bay High." All of the periods of very high burning index in Minnesota and Upper and Lower Michigan were associated with that weather type, as were seven of the eight periods in Wisconsin.

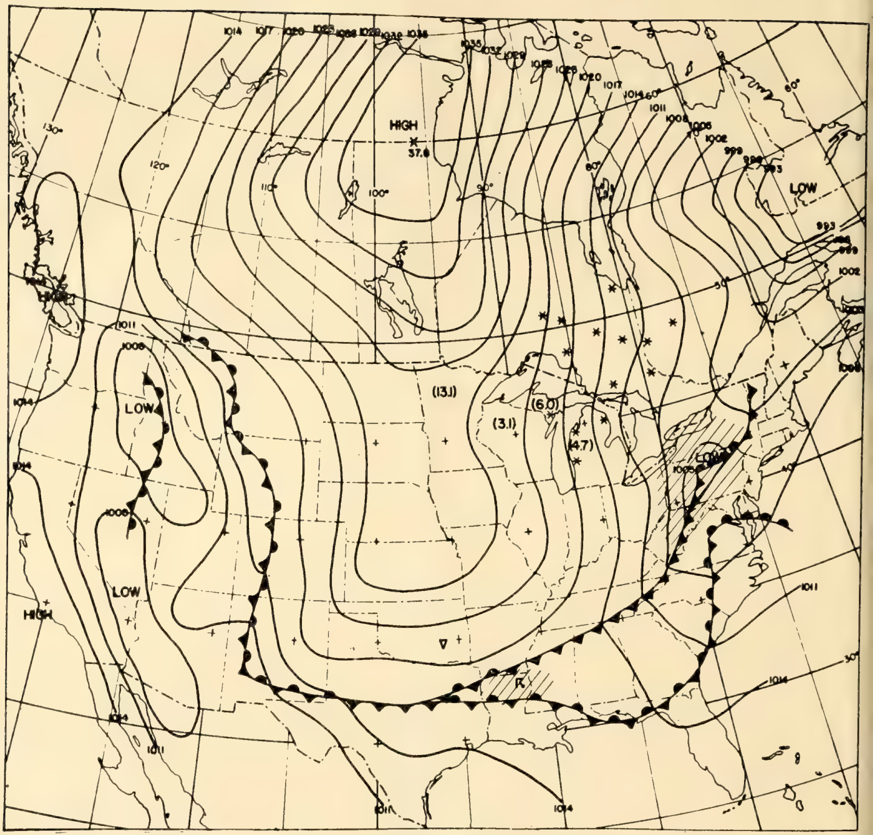
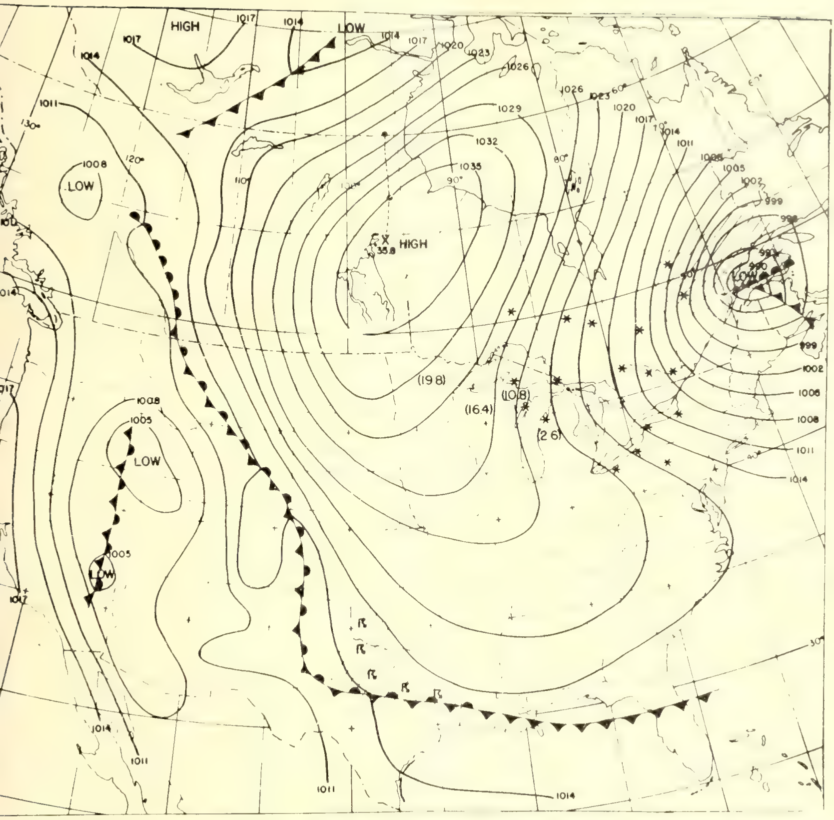


FIGURE 4.—Surface map for 6:30 a. m. May 7, 1947. The average burning index in each of the Lake States is shown by the figure in parentheses. Stars indicate snow and hatched areas are areas of more or less continuous precipitation.

The one Wisconsin period which was different, and the one April case that was found, were associated with highs that moved from western Canada through the Lake States in a southeasterly direction.

It was interesting to note that there was no case in May of the years studied in which a Hudson Bay high moved southward or south-southeastward from the Hudson Bay region, that was not associated with a period of very high burning index in Wisconsin.

Composite maps shown in figures 1 through 3 show definitely that the Hudson Bay type is associated with critical burning conditions in the Lake States in May. Figure 1 is a composite sea-level map for 6:30 a. m., 2 days before the first day of very high burning index for the Minnesota cases. Figure 2 is a composite map on the morning of the first day of very high burning index, and figure 3 is one for 2 days later. The first of this series shows a rather intense high located on the west shore of Hudson Bay with a ridge of high pressure extending southward through the Plains States; a very dry situation for Minnesota and usually Wisconsin and Upper Michigan. The burning index at this time is already high over Minnesota (16.2), and at some stations very high, but the average over the State does not become very high until 2 days later. By then (fig. 2) the high center has



IGURE 5.—Surface map for 6:30 a. m. May 8, 1947. Past 12-hourly positions of the Hudson Bay high are shown by dots and its path by a dashed line.

noved southward to extreme western Ontario. The high pressure idge has moved eastward to the Mississippi Valley and has built outhward to the Gulf coast. Two days later (fig. 3) the high center as moved to the middle Atlantic coast and diminished in intensity, vhile lower pressure has moved into the northern plains. The burnng index in Minnesota is still very high, but is about to be reduced y rainfall.

Similar composite maps (not shown) for the seven Wisconsin cases f very high burning index were drawn and show generally the same attern. No composite maps were drawn for the critical periods in Jpper and Lower Michigan. Since each of these periods occurred vith a weather situation that also produced a critical period in Wisonsin, there is no doubt that a similar pattern would result.

The length of the critical periods in Minnesota ranged from 1 to 6 ays with an average of 3½. In Wisconsin the range was from 1 to days with an average of 3, in Upper Michigan 1 to 3 days with an verage of 2, and in lower Michigan 1 to 6 days with an average of 3. Jsually the period of very high burning index associated with a single Iudson Bay high was 2 to 3 days. During longer periods an addiional high passed through or near the Lake States. The second one vas either another of the Hudson Bay type or one from northwestern Canada moving southeastward. What usually happened in these

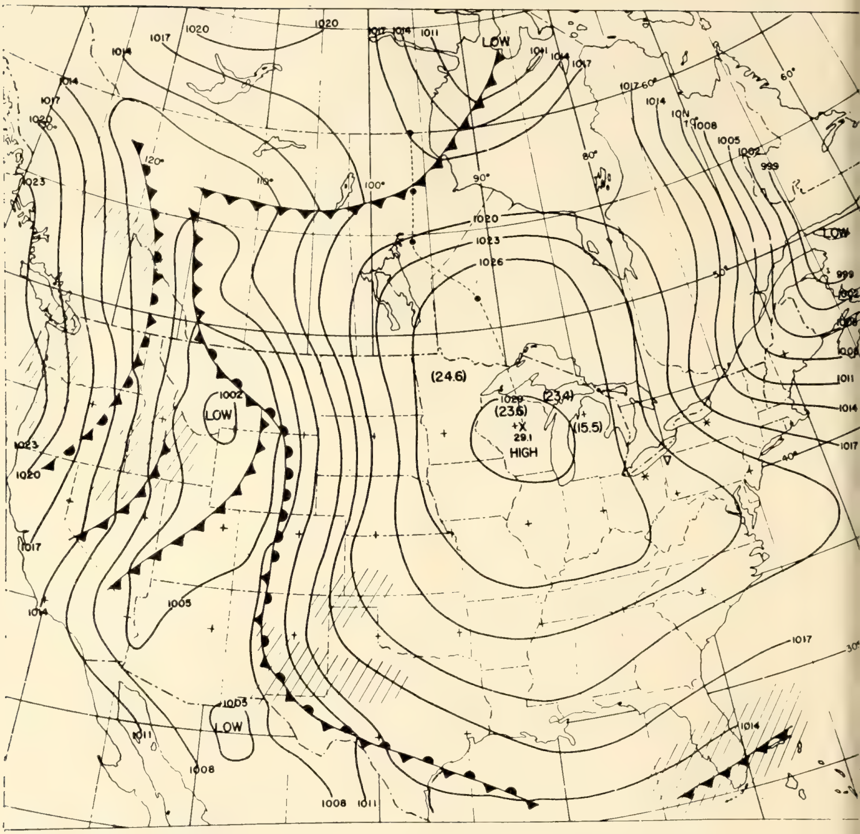


FIGURE 6.—Surface map for 6:30 a. m. May 9, 1947.

cases was that the precipitation following the Hudson Bay high did not cover all of the Lake States, and in the areas where none occurred the burning index remained very high during the passage of the next high.

Previous studies have shown that Hudson Bay highs are more frequent during the month of May than any other month; also that their mean path has a more southerly direction in May than in April. This may account for more periods of very high burning index being found in the Lake States during May than during April.

TYPICAL CASE

A typical weather sequence involving a Hudson Bay high is shown in the 6:30 a. m. sea-level maps for May 7–11, 1947, reproduced in figures 4–8. This weather sequence was chosen because it was associated with a period of very high burning index in each of the Lake States.

On the first day of this sequence the average burning index in Minnesota was already high (13.1); the fire-weather stations in that State having been without measurable precipitation for 3 to 5 days. Stations in Wisconsin and Upper Michigan had been without precipitation for 1 to 4 days, and in Lower Michigan 1 to 3 days. Measurable precipitation was reported at some stations in Lower Michigan as late as the morning of the 8th.

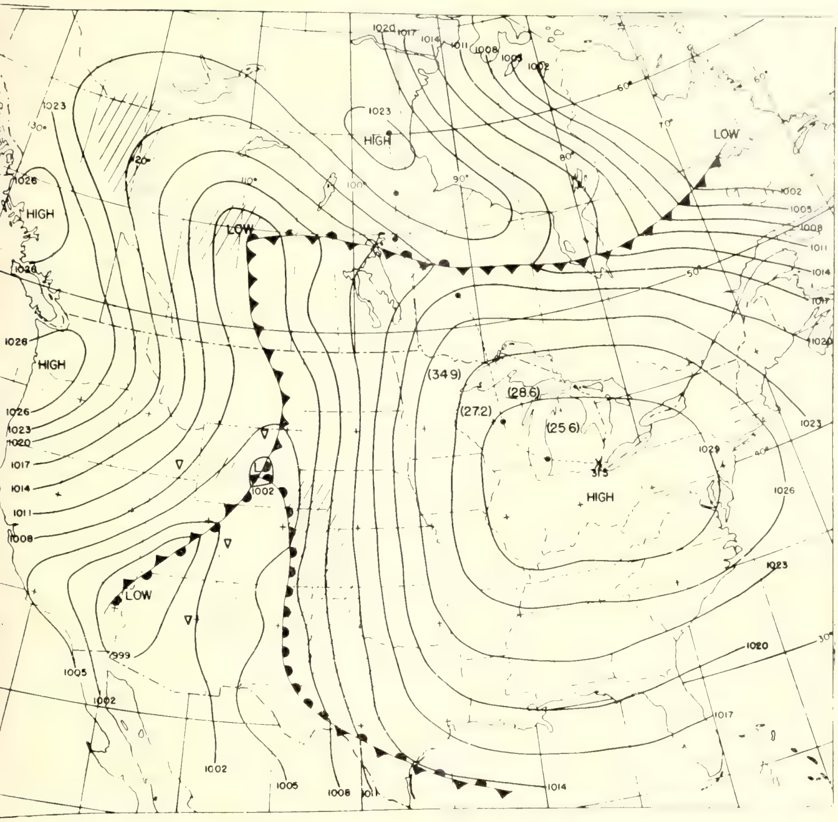


FIGURE 7.—Surface map for 6:30 a. m. May 10, 1947.

As the high moved southward on the 8th, the relative humidities in Minnesota and northwestern Wisconsin lowered; noontime readings being generally in the 20's and 30's in these areas. When the center of the high moved to Wisconsin on the 9th, humidities lowered considerably in both Upper and Lower Michigan and the rest of Wisconsin, being under 20 percent at several stations at the noon reading. The burning index increased correspondingly, reaching the very high classification in Minnesota.

The winds became predominantly southwesterly on the 10th and increased in velocity in Minnesota, Wisconsin, and Upper Michigan, while the humidities changed little or increased slightly. (Winds blow in a clockwise direction around a high with a slight cross-isobar component from high to low pressure. The wind velocity is inversely proportional to the spacing of the isobars; that is, the closer together the isobars, the stronger the wind.) The burning index then rose still more, becoming very high in all of the Lake States. It should be noted that the average burning index in Lower Michigan rose from low to very high in only 2 days.

A trough of low pressure began to move into northwestern Minnesota on the 11th as the high moved southeastward to the Virginias. Dry conditions still prevailed in Wisconsin, Lower Michigan, and portions of Minnesota, but rain at some stations in Upper Michigan and

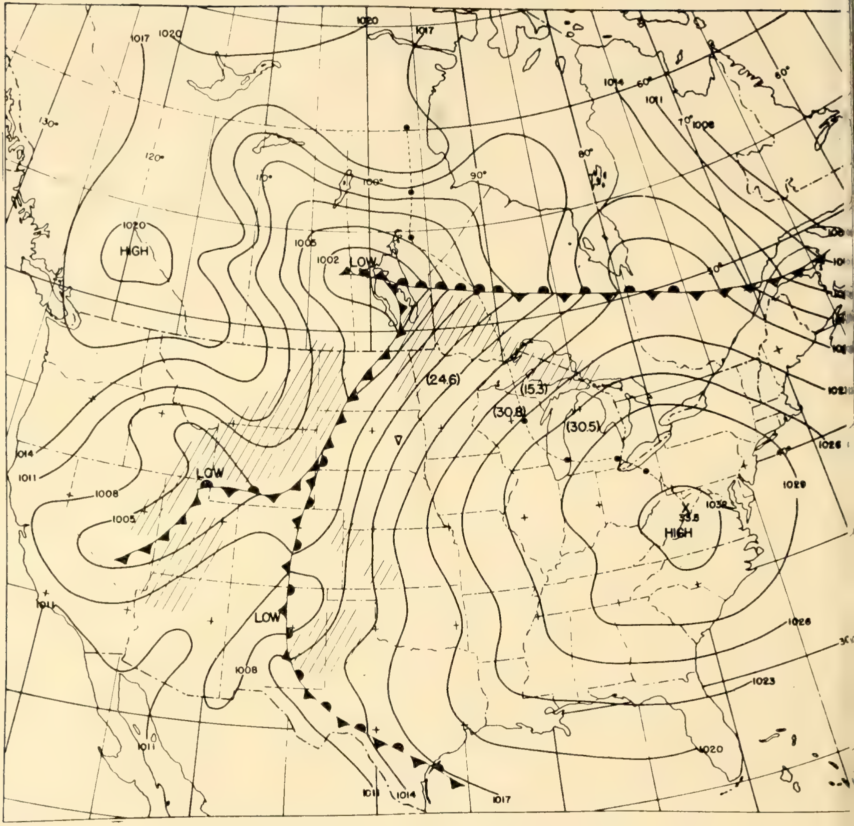


FIGURE 8.—Surface map for 6:30 a. m. May 11, 1947.

Minnesota diminished the average burning index in those two areas Rain finally reduced the burning index to the low classification, o lower, in Minnesota and Upper Michigan on the 12th and in Wiscon-sin and Lower Michigan on the 13th (maps not shown).

It is interesting to note the similarity between this typical situatio and the composite maps for the Minnesota cases by comparing figure 1, 2, and 3 with figures 4, 6, and 8.

CONCLUSION

This study suggests that the Hudson Bay high is the principal weather type associated with periods of very high burning index in the Lake States in May, although other situations may occur. It is not reasonable to conclude, however, that critical burning conditions asso-ciated with Hudson Bay highs do not occur in April.

Knowing the relationship between the Hudson Bay high and the burning index should be an aid in producing longer-range fire-weather forecasts of impending critical burning conditions in the Lake States. The accuracy of the forecasts, however, will be contingent upon the forecaster's ability to foretell the development and move-ment of the Hudson Bay high.

CHEMICALS FOR FIRE PREVENTION

Alva G. Neuns

California Forest and Range Experiment Station

Propaganda alone will not prevent man-caused fires. Active prevention aimed at fireproofing rights-of-way and other areas of concentrated use is often a greater need.

Annual grasses and weeds are commonly the fuels most susceptible to fire on such areas in many forest regions. Their removal is frequently the only practical way to prevent fires. Hand grubbing, power scraping, burning, cultivating, and spraying with petroleum oils are among the methods used to get rid of fuels. Too often the effects are not what they should be. High costs and the need for annual retreatment result in sporadic and incomplete results. In the search for a cheaper and more permanent method, chemical treatment has been tried and found to be the answer in many cases.

Annual fireproofing is necessary when a regrowth of plant cover must be encouraged each year to hold the soil in place during periods of heavy rains. The objective of chemical treatment is to reduce the yearly cost. Sodium chlorate and polybor-chlorate are used for annual treatment. Long-time sterilization may be used where soil can safely be maintained bare of vegetation. Arsenic trioxide, R. C. A., and Borascu will prevent growth of plant cover for several years and are therefore economical to use.

Sodium chlorate.—Sodium chlorate in water solution is an effective spray for killing annual grasses and weeds. It is quick-acting and comparatively low in cost. It should be applied after heavy rains are over and the need for plant cover is no longer critical. The fireproofing job should be complete, however, before the dry season in order to meet the prevention need. Its sterilizing effects are temporary because it will leach from the soil during the rains preceding the following growing season.

One-half to one pound of sodium chlorate per gallon of water will give complete kill of most weeds and grasses. Heavier dosages saturating lower stems and the ground may be used to kill shrubs and perennial weeds. Some easy to kill species may call for a weaker mixture. Enough solution should be sprayed with enough force on the foliage to thoroughly wet the leaves and stems. Power spray equipment is generally used. The cost of sodium chlorate in California is $107.50 per ton or approximately $5.37 per hundred pounds. Prices may differ in other areas.

Because sodium chlorate is highly combustible when applied to organic material, it should never be used immediately preceding or during periods of high fire danger. Risk to men and equipment through the use of chlorate can be almost wholly overcome by observing strict rules for storing, handling, and applying. The following points from Purdue University Extension mimeograph No. 1 should be kept in mind:

Precautions (when in contact with organic matter sodium chlorate creates a fire hazard):

1. Store sodium chlorate in tightly closed metal containers.
2. Do not spill sodium chlorate in automobiles, trucks, or in buildings.
3. Avoid using sodium chlorate near buildings. On such areas, remove all vegetation and apply material on the soil to reduce fire hazard.
4. Do not allow clothing to become saturated with sodium chlorate solution.
5. Wear rubber boots when applying sodium chlorate.
6. Keep sodium chlorate out of reach of livestock. Do not pasture treated areas until the plants have dried or the material has been washed into the soil by heavy rains.

Hundreds of tons of sodium chlorate are used each year on hundreds of miles of roadside strips and for large scale noxious weed control in California. This demonstrates that it can be used successfully. There have been cases of improper use in dry periods following very light fall rains. A few years ago several fires in southern California apparently were started when passing cars rubbed against roadside weeds sprayed with sodium chlorate. Fortunately, these are rare and can be avoided if good judgment is used in choosing time of application.

Polybor-chlorate.—Polybor-chlorate was developed to eliminate the fire hazard associated with chlorate for use in places where rainfall is very low, dry seasons are long, and fire danger continuously high. Its manufacturers claim a killing strength equal to chlorate when sprayed on foliage in a mixture of 1½ pounds per gallon of water. Although its sterilizing effect on the soil has not been observed past the first year, it is not expected to differ from chlorate. Possible disadvantages include a slightly higher cost ($140 per ton in California) and a poisoning effect on citrus trees because of the addition of boron.

Arsenic trioxide.—Arsenic trioxide (usually called white arsenic) is known to have caused soils to remain sterile for periods of 10 years or longer. Wherever erosion is not a problem and the soil can remain undisturbed after treatment, effects are long-lasting. Treatment should be limited on most soils to slopes under 25 percent. Steeper slopes may be treated if the soil is very stable. White arsenic is usually applied after all annual growth has been cleaned from the area to be treated. The chemical is easily applied in dry powder form by hand or with spreaders at the rate of 4 pounds per square rod on most soils. Coarse sand and heavy red clays require more. It should be put on during the rainy season or set down afterward to prevent wind loss.

The cost in California is 6 to 8 cents per pound. Labor and transportation costs are low owing to the small quantities needed to produce long-lasting effects. Even though white arsenic is a poison, it is not hazardous if reasonable care is used in handling and storing. It does not attract game or wildlife and is therefore not a hazard to them.

A good example of the use of white arsenic is to be seen on the Shasta National Forest. It was applied in April 1940 to bulldozed and hand-cleared fire lines. Forest officers cooperated with the Southern Pacific Company on a project to fireproof their railroad right-of-way. In 1948, 100-percent sterilization was still in effect (fig. 1).

R. C. A. (*razorite concentrate anhydrous*).—R. C. A., or razorite, is a boron ore in granular form which is often used when white arsenic is not available or for some reason cannot be used. Applied by hand or spreaders at the rate of 25 pounds per square rod, it is equal to arsenic trioxide as a soil sterilant. Because R. C. A. is somewhat

water-soluble, however, its effects are less permanent: depending on the amount of annual rainfall, it will leach from the soil in 3 to 5 years. Because of its granular form R. C. A. may have some disadvantage where wind loss is a problem.

The cost of $60 per ton, large volume of material to be handled, and the less permanent results make it a more expensive material to use.

Borascu.—Borascu, an unrefined boron ore in granular form, similar to R. C. A., is also widely used. The cost is $35 per ton, but its soil sterilizing strength is only half that of R. C. A., and therefore twice as much material must be applied to do the same job. It may be more readily available than R. C. A. or white arsenic in some areas.

FIGURE 1.—Fire line along railroad right-of-way 8 years after treatment with arsenic trioxide.

FIRE PUMPER TESTING AND DEVELOPMENT

Arcadia Fire Control Equipment Development Center
Region 5, U. S. Forest Service

A continuing project at the equipment development center is pumper testing. Not only are pumps tested as to compliance with specifications, but also any new developments and designs in pumper units that give promise of possible use to the Forest Service are given short test runs. The purpose of the program is to insure that pumpers offered as meeting specifications are adequate for Service needs and that new developments in equipment are immediately available.

Pumpers purchased under existing Forest Service specifications are required to have passed an approval test including a 100-hour operating test. The 100 hours in actual practice represents the approximate operating time that many units are used during a fire season. In effect, it insures that a pumper put into service can be expected to at least perform at rated output and pressure during a season without need of repairs.

Another Forest Service specification requirement tested is that pumps under normal operating conditions should require only 80 percent of the horsepower output of the driving engine when operating at sea level. This requirement is important since the average gasoline engine decreases in horsepower output approximately 3 percent for each 1,000 feet above sea level. We are thus assured that pumpers will operate at rated output up to elevations of 7,000 feet without overloading the engine. Under operating conditions below this elevation, the engine not being operated at peak output can be expected to have a longer service life.

The main equipment used in the tests are recording flow meters, pressure meters, and vacuum meters, which are operated in parallel with indicating gages of the same types. All equipment is calibrated preceding each test run and the purpose of dual instrumentation is to insure that any failure in meters will be immediately apparent and corrected. The complete description of testing equipment and procedure of the tests has been covered in a Pumper Test Procedure Report, which is available at the Development Center.[1] A general view of the test stand is shown in figure 1. The equipment is used, not only to check pumpers, but also to test hose, strainers, nozzles, and any other equipment through which water flows.

Before starting the 100-hour pumper test, a series of runs are made to give data regarding the output of the unit under pressure ranges from free discharge to the maximum pressure obtainable. Runs under varying suction lifts are also made to show the ability of the unit when

[1] Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 Santa Anita Ave., Arcadia, Calif.

drafting. This same series of tests is performed at the conclusion of the 100-hour run and the comparison of values before and after are an indication of wear and decrease in efficiency. Units are checked before and afterward for clearances and, if efficiency drops to any great extent, are completely dismantled and checked against manufacturer's specified tolerances.

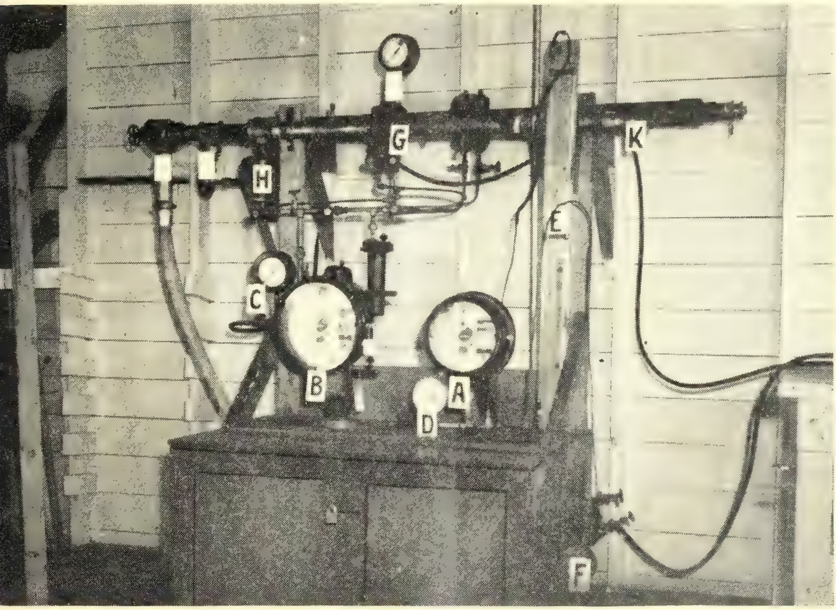


FIGURE 1.—Pumper testing equipment: *A*, Draft (vacuum) recorder; *B*, discharge pressure and rate recorder; *C*, discharge pressure gage; *D*, draft (vacuum) gage; *E*, draft gage (mercury manometer); *F*, hand-operated priming or vacuum pump; *G*, orifice meter piping; *H*, discharge pressure (back pressure) regulator; *K*, intake connection to orifice meter piping.

In performing the 100-hour test, units are run intermittently for the first 50 hours and continuously for the final 50 hours. During intermittent operation, items such as ease of starting, and procedure of starting are noted. The final period is used as an indication of the unit's ability to perform over long periods.

Other pertinent details, such as adequacy of design, fuel consumption, and general suitability for the varying needs of the Service are checked.

In checking new pump designs only the tests that are normally run as preliminary to the 100-hour test are performed. This is usually sufficient to provide proper data that indicates whether or not the unit warrants further investigation.

Many interesting facts have been brought to light as the result of the pumper tests. Of two units submitted by different manufacturers, the volume of water pumped by both was in excess of that which could be efficiently handled by the factory recommended suction and discharge hoses. An increase to the next larger hose size on the suction side increased the volume of water pumped by approximately 10 percent. On the discharge side, an increase to the next larger hose

size reduced pressure drop by approximately 90 percent. One unit was redesigned for a lower volume and higher pressure, and on subsequent tests, performed adequately. A change was made in the inlet and outlet fittings of the second unit, which allowed for the use of the next larger size of hose.

Of two other units tested for the same manufacturer, the first by actual weight was 60 percent lighter than the second one and had an output at the same rated pressure approximately 35 percent less. However, the efficiency of the pump and engine was such that when compared with all accessories and with sufficient fuel for 24 hours of operation, the units had approximately the same over-all weight. This indicates that over-all weight for a given operating period, and not weight of the pumper only, should be considered when deciding on what type of equipment is to be used.

To date three units have been 100-hour tested. Two more units are scheduled and will be completed in the near future. The pressure volume rating for the three units mentioned above are as follows:

Pressure (pounds per square inch)	*Volume discharge in gallons per minute*		
	Pump A	*Pump B*	*Pump C*
0 (free discharge)	24	42	18
100	22	39	17
250	18	30	10
310	16	25	--

Complete specifications have been written, under which approximately 85 pumps of the above sizes have been purchased and placed in field operation.

Approximately 10 additional units have been spot-checked. Of these, two merit further study and, after redesign, will again be submitted by the manufacturers.

Fire Guard Improvises Antenna for Handi-Talkie on Project Fire.—The following story is quoted from a letter by Supervisor Kooch of the Salmon Forest, regarding use of Handi-talkie by Ranger Alternate J. G. Denny.

"Our first chance to try out the new Handi-talkie, Forest Service type FS sets, on this district was on the Dutch Oven Fire, with three of the sets in strategic positions on the fire and one on an observation point. They certainly worked beautifully.

"While on mop up on this fire we had two Handi-talkies for communication on the fire and also for communication with the dispatcher in Salmon via Long Tom Lookout.

"We had moved our camp to a more suitable location and somewhere in the shuffle we lost the antenna for one of our Handi-talkies. I experimented with a length of No. 9 telephone wire inserted in the antenna socket. I could send and receive all right but the wire was so loose in the socket that it caused a great amount of static.

"Through inquiry at camp I discovered a short length of antenna from an automobile radio, and a stove bolt of the desired size. By fastening the stove bolt to the antenna with a gob of solder, I had an improvised antenna that would transmit and receive at a distance of more than 10 miles.

"The little Handi-talkie is the answer to a fire fighter's prayer."—Francis W. Woods, *Communications Engineer, Region 4, U. S. Forest Service.*

A NEW MEASURE OF THE SEVERITY OF FIRE SEASONS

A. W. LINDENMUTH, JR., *Forester, Fire Research, Southeastern Forest Experiment Station*, and J. J. KEETCH, *Danger Station Inspector, Region 7, U. S. Forest Service*

A new method for expressing the severity of fire seasons in terms of number of fires is now being tried in the Northeast. The number-of-fire rating is computed from a weighted risk factor which is derived by relating the actual occurrence to the burning index measured at fire-danger stations. Thus, when the computed risk factor is held constant, the fluctuations in number of fires are in direct proportion to changes in fire danger. The actual risk does not usually remain constant, of course, since every fire control agency is working to reduce it. Also, intermittent strikes or a sudden increase in forest visitors, as during hunting season in bad fire weather for example, increase the normal risk for short periods. The actual occurrence, therefore, is not necessarily in direct proportion to the expected occurrence, which is based on season rating. It will be so only if the risk remains constant. The difference between actual and expected fires, or the ratio of one to the other, is meaningful as a guide in determining whether an unusual number of fires is primarily due to a change in risk or a particularly bad or easy fire season.

The accuracy of the new technique has not as yet been fully determined. While the burning index scale on meters 5–W and 5–O was intentionally made directly proportional to average fire occurrence in the Northeast, this relationship had not been thoroughly tested. Several years of records will be needed to define the limits of error. Certain improvements in the integration of the measurements may be necessary. At the present time, however, the method for rating fire seasons outlined here gives fire administrators a useful tool to weigh trends in fire occurrence.

As an illustration, when the number of fires in a district drops year by year from a high of 334 to a low of 88, something has happened—but what? Have fire seasons been successively easier, or has a particularly effective prevention campaign been waged.

This reduction has occurred in a flatwoods protection unit of one of the seaboard eastern States. The situation is illustrated in graph *A*, figure 1. The solid line shows the steady reduction in man-caused fires from 334 to 88 over a period of 5 years. The dashed line shows the expected number of fires, or the season ratings, for the same period. In the lower half of the graph the stippled area shows the trend in fire occurrence, or the proportional relationship between the actual fire occurrence and the season rating. The ratio is determined by dividing the actual number of fires by the season rating.

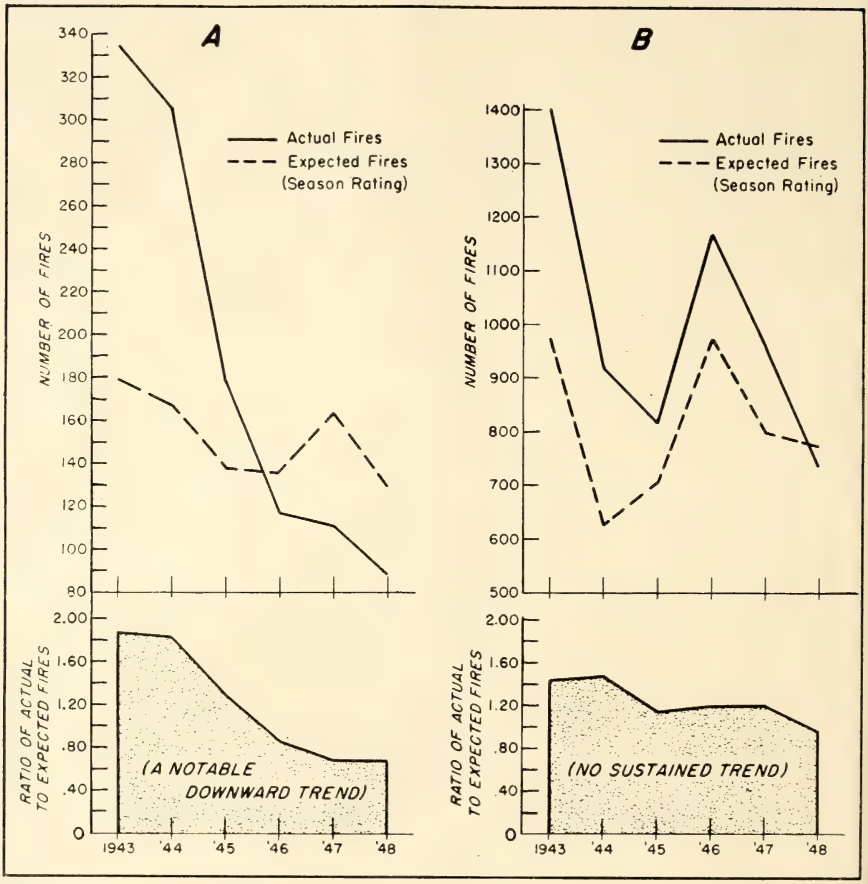


FIGURE 1.—*A*, An efficient prevention campaign reduced fire occurrence more than measured fire danger would have indicated. *B*, The lack of any major trend in fire occurrence indicates that the actual number of fires was controlled chiefly by the weather.

In graph *A* the actual number of fires was reduced more each year than measured conditions normally warranted. This reduction did not happen by chance. It was caused by a well-planned, sustained fire prevention campaign carried on during the 5 years.

Graph *B* indicates a different situation in a different area. Here the lack of any major trend in fire occurrence (in relation to the season rating) means that the actual number of fires was controlled chiefly by weather. This is particularly true of the sharp reductions in fire occurrence during 1944 and 1947 as well as the big increase during 1946. This does not imply that no efforts were made to reduce the number of fires. A prevention program was carried on; however, no major change in emphasis was made in the program during the period. So this is an example of what one would normally expect if there is no notable shift in fire risk or prevention efforts.

Graphs *A* and *B* illustrate the new method which helps to explain the reasons for changes in number of fires and shows up trends in fire

occurrence. It can be used to measure the effectiveness of prevention campaigns, to help fire administrators estimate the number of fires which should have occurred in any period, and to establish annual or periodic fire control objectives. One of its apparent advantages is that it substantiates the benefits of good work.

In order to draw valid conclusions from season ratings regarding trends or patterns of fire occurrence, the ratings must be based upon measured values. In this method, the season rating is determined by measured fire danger, preferably as integrated by the type 5–W or type 5–O meters.[1] These meters carry burning index scales of from 1 to 100 which were intentionally made directly proportional to the number of man-caused fires in the Northeast. This means, for instance, that as the burning index doubles, the number of man-caused fires, on the average, also doubles. Thus, the number of fires by years on a particular unit should vary as the sum of the indexes for the same period, so long as the area protected remains the same. If that does not hold true, one may logically conclude that either the degree of human risk or the habits of the fire-starting agents have changed.

However, if one wants to compare the severity of fire seasons between different units, a mere comparison of the sum of the burning indexes is not sufficient. When two or more units enter into a comparison, there are differences in area, population, fuel types, topography, attitudes, and habits of the people, and many other things besides the weather factors. These many overlapping factors affecting fire occurrence must be properly weighted.

Weighting can be accomplished and comparisons among units made possible by converting burning indexes for each unit into expected number of fires for a month, season, or year, as desired.

This conversion from burning index to expected number of fires is effected in this method by:

1. Calculating a risk factor for each month during the 5-year period 1943–47 by dividing the number of fires each month by the sum of the daily burning indexes for that month.
2. Choosing for each month the 3 years having the lowest risk factor. For example, in May the risk factors by years might be as follows:

Year:	*Fires*	*Burning index*	*Risk factor*
1943	39	291	0.1340
1944	43	392	.1097
*1945	18	206	.0874
*1946	4	65	.0615
*1947	16	406	.0394

The three years marked with asterisks would thus be selected.

3. For each month summing the number of fires and burning indexes for the three selected years and dividing one by the other to obtain a weighted average risk factor. Thus from step 2 the factor would be 38 divided by 677, or 0.0561.
4. For each month of the year to be rated, multiplying the weighted average risk factors by the burning indexes. The sum of monthly ratings is the year rating.

[1] Distributed by the Southeastern Forest Experiment Station for use in the Northeastern States and the mountainous sections of the Southeast.

In the foregoing the average of the three lowest years was selected as a rating base because that seemed a reasonable objective. Obviously, an average of the 5 years or any single year could have been used.

The method can be applied not only to individual protection units, but also to national forests, States, regions, or even larger areas. Ratings for these can readily be built up by adding together the ratings from all of the individual units included. As a result, this method may be used in any area, regardless of size, where fire occurrence can be related to measured fire danger.

Examples of composite ratings for larger areas are shown in figure 2 by a second pair of graphs. Graph *C* presents the data for an eastern State, graph *D* an eastern national forest. These particular examples are chosen because they show a difference in the trend of fire occurrence. In the case of the State (graph *C*) a steady reduction in the number of actual fires over and above what one would expect is indicated, whereas on the national forest (graph *D*) no particular trend is indicated; the actual number of fires sometimes is greater and sometimes is less than the season rating.

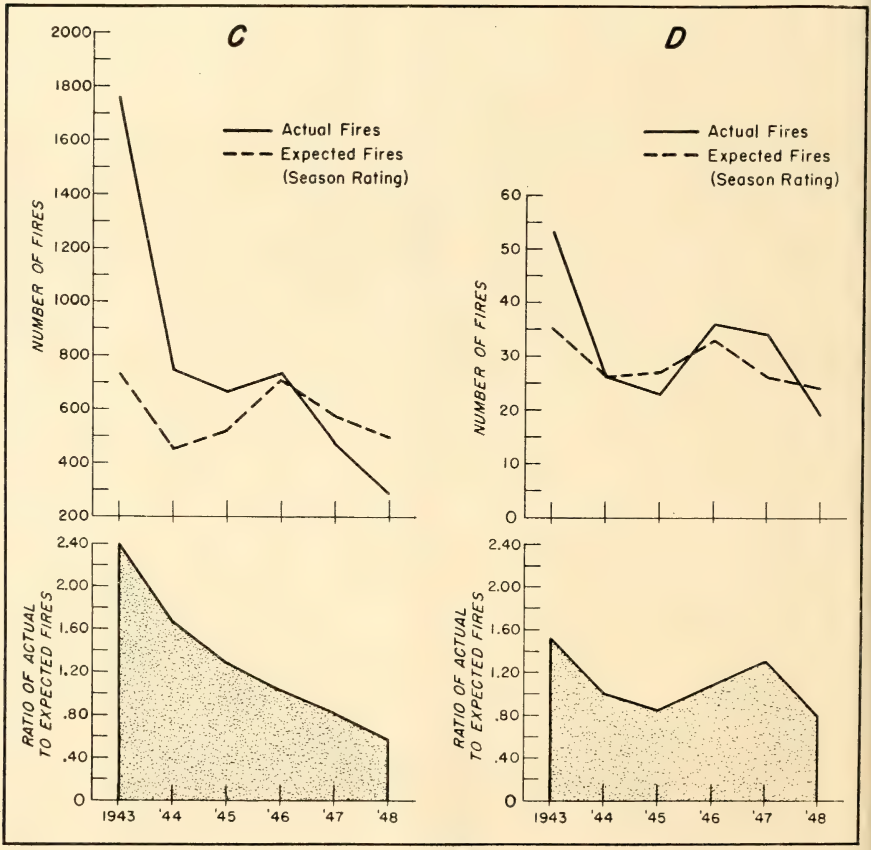


FIGURE 2.—*C*, Debris burning laws and enforcement were effective in reducing fire occurrence in this eastern State. *D*, Records from an eastern national forest show what may be expected when there is no outstanding change in fire risk or prevention efforts.

The reduction in number of fires in the State has been steady and continuous for the past 5 years. The decline started with the passage of legislation restricting debris burning, which was the major cause of forest fires in this State, and the downward trend has been sustained by active enforcement of the law. From these data it appears that the efforts have been highly successful in reducing the number of wild fires. However, since the number of fires has already been reduced from 240 percent of the season rating to only 56 percent of the number expected according to measured fire danger, the downward trend may soon be arrested; the ratio between the actual number of fires and the expected number may remain relatively constant in the future. That would indicate that either a practical minimum in the number of fires has been reached or a change in emphasis must be made in the prevention program in order to reduce the number of fires originating from causes other than debris burning.

Perhaps the national forest used as the example may have already reached the point where further reductions in number of fires can only be made by very specialized prevention efforts. Whether or not this is true can only be determined by the responsible administrative officers. The data, however, point up the fact that there is no marked trend either toward a reduction or an increase in the actual number of fires over and above the season rating.

Of course, the State or national forest ratings do not tell the whole story, since by comparison some of the districts may not have made as much progress in reducing the number of fires as the others. The method reported here, in addition to pointing out regional or sectional trends, should be helpful in aiding administrative officers to focus attention on troublesome units and periods. Then specific problems can be isolated and attacked.

Wet water.—Studies on use of wetting agents, under way at Pilgrim Creek in Shasta National Forest, are emphasizing two facts. One is that increased efficiency through use of wet water under field conditions depends on using proper equipment and techniques of application. Another, perhaps equally important, is that a great deal of improvement in use of plain water might be realized through study of application techniques.

The men working with W. L. Fons on this project spent 6 weeks developing equipment and techniques in field use. These tests paid off. The men are now collecting data on comparisons of wet and plain water. So far, they have measured as much as 2 to 1 superiority for wet water; that is, only half as much water was needed with wetting agents and proper techniques.

Laboratory work had promised improved efficiency with wet water; but before methods of application and necessary experimental controls were worked out, wet and plain water appeared about equal in field use. Now wet water leads, and plain water has been used more efficiently.—*Staff Notes, California Forest and Range Experiment Station, 9–13–49.*

EFFECT OF LITTER TYPE UPON FUEL-MOISTURE INDICATOR STICK VALUES

W. L. Fons and C. M. Countryman

California Forest and Range Experiment Station[1]

Instructions for establishing fire-weather stations in Region 5 have usually specified that the fuel-moisture indicator sticks be placed over a bed of ponderosa pine needles. This specification was made to insure uniform ground-cover effect for all stations. Because ponderosa pine needles are not readily available in all areas of California, fire control technicians have often asked if pine needles must be used in preference to local litter types.

To answer this question, the effect of litter type on fuel-moisture indicator stick values was measured as part of other litter studies at the Shasta Experimental Forest. Eight common types of litter were used: (1) ponderosa pine needles (*Pinus ponderosa*), (2) California black oak leaves (*Quercus kellogii*), (3) snowbrush leaves (*Ceanothus velutinus*), (4) manzanita leaves (*Arctostaphylos* spp.), (5) white fir needles (*Abies concolor*), (6) bitterbrush leaves (*Purshia tridentata*), (7) mixed conifer needles (including white fir, ponderosa pine, sugar pine, incense cedar), (8) cured grass.

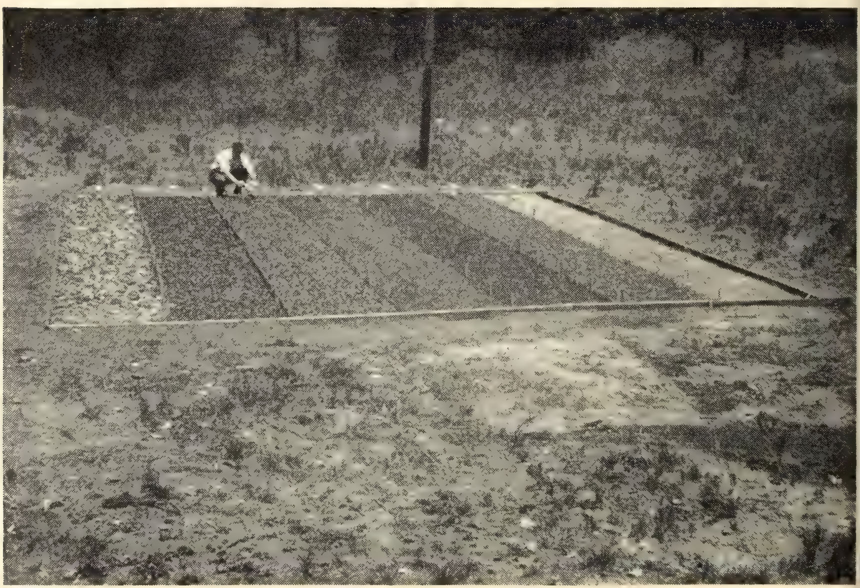


Figure 1.—Litter beds used in fuel-moisture studies at the Shasta Experimental Forest. Litter types from left to right are: Oak, snowbrush, manzanita, white fir, bitterbrush, mixed conifer, grass. The ponderosa pine litter bed (not shown) is a few feet to the left of the oak litter bed.

[1] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California, Berkley, Calif.

Beds 3 feet wide, 30 feet long, and 3 inches deep were prepared for each kind of litter. A fuel-moisture stick was exposed 10 inches above each bed on wire supports (fig. 1). The sticks were weighed to the nearest 0.1 gram on a torsion balance at 4 p. m. daily.

After the sticks were tested over different litters, all of them were exposed over the ponderosa pine needle bed and weighed regularly to measure the variation in individual sticks. Curves were drawn showing the relation of the observed moisture content of each stick to that of the stick over ponderosa pine needles. These curves were then used to correct the observed stick moistures for stick differences.

The data for the stick over ponderosa pine needles were grouped into two broad moisture content classes. Then the average corrected moisture content was computed for the other sticks in each of these two classes. The indicated moisture content at 4 p. m. of these fuel-moisture sticks exposed over 8 kinds of litter was as follows:

	Moisture content (percent)		
Litter type:	*3.5–5.9 percent class* [1]	*6.0–8.4 percent class* [2]	*Average* [3]
Ponderosa pine needles	5.1	6.6	5.7
Oak leaves	5.1	6.2	5.6
Snowbrush leaves	4.9	6.2	5.4
Manzanita leaves	5.1	6.2	5.5
White fir needles	5.2	6.0	5.5
Bitterbrush leaves	5.3	6.1	5.6
Mixed conifer needles	4.7	6.1	5.2
Cured grass	5.0	6.0	5.4

[1] Basis: 13 days. [2] Basis: 9 days. [3] Basis: 22 days.

None of the fuel-moisture sticks exposed over the different litter types used in this study showed any significant difference in indicated moisture content. Morris [2] found that there is no difference in the moisture content of sticks exposed 9 inches and 12 inches above Douglas-fir litter, bare ground, and gravel. It is thus probable that the type of ground cover immediately under fuel-moisture sticks is relatively unimportant when the sticks are exposed 9 inches or more above the surface. Ground cover of some type of dry litter is advisable, however, to keep the sticks from being splashed with mud during heavy rain.

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[2] MORRIS, WILLIAM G., EFFECT OF GROUND SURFACE AND HEIGHT OF EXPOSURE UPON FUEL MOISTURE INDICATOR STICK VALUES. Pacific Northwest Forest Expt. Sta. Forest Research Note 30, pp. 5–6. 1940. [Processed.]

CONVERSION OF A MILITARY CARGO CARRIER INTO A TANKER TRAILER

GILBERT I. STEWART

Supervisor, Michigan Forest Fire Experiment Station

Among the many vehicles declared surplus by the armed forces is a small trailer, known officially as "Trailer, dump, 2-wheel, ½-ton, air-borne." It was designed for use as a general cargo trailer, and was matched in size, capacity, and tread with the jeep. Most of the repair parts are interchangeable with those of the jeep, especially the running gear. The vehicle is fully covered in Technical Manual TM5–9084. Many of these trailers were sold as surplus items, and fire control agencies will find in them a useful vehicle for conversion to flat-tank water carriers.

During 1947 the Michigan Forest Fire Experiment Station carried out a rather extensive research project dealing with tanker design, in conjunction with the military jeep, the Dodge power wagon, and a number of tanker trailers to accompany them as accessory water carriers. One phase of this work was concerned with the trailer described above, and from it was developed a pilot model that might be of interest to other fire control agencies.

Reference is suggested to TM5–9084, but in case a copy is not available, a brief description and the accompanying photographs might clarify this report. The trailer is manufactured as a dump trailer and the bed is a sturdy metal box manufactured as a single piece. A heavy tail gate is provided to permit use as a dump box. There are no springs on the unit. Full electrical equipment is installed for taillights.

Examination of the box suggests the removal of the tail gate and the substitution of a rear bulkhead welded all around and made watertight. With additional baffle plates, angles, and cross members, the original dump box can be converted into a splendid water tank, with valuable features of design that cannot be found usually in commercial tanks (fig. 1).

For sake of completeness in describing conversions, the following details may be left unchanged:

1. The dumping feature need not be changed, although convenience in the installation of plumbing and intake hoses might determine otherwise.
2. The pintle hook for towing may be retained, if the towing vehicles are equipped with the corresponding hook. Otherwise, some sturdy type of ball hitch is required and the standard ball in the 2-inch size is recommended.
3. Tail lighting fixtures may be retained. The plug will fit into the standard socket supplied on the military jeep. Otherwise, some suitable set of plugs and sockets may be selected as standard between all towing vehicles.
4. The leg pedestal should be left intact.
5. The lack of springs under the bed is no particular disadvantage and need not be corrected.

Possible changes are as follows:

1. If the dumping feature is discarded, remove all mechanism associated with tripping and locking. These are the tail-gate catch, dump release assembly, trip handle assembly.
2. Tail gate must be replaced with a solid steel rear bulkhead, preferably not heavier than ⅛-inch. Fitting the new piece must be accurate to conform to the size and shape of the box, and to permit a watertight weld along all sides.
3. It might be found desirable to replace the pintle eye (lunette eye) with a longer tongue to permit closer turning, or to guarantee necessary clearance if the vehicle is used behind tractors.
4. Install supporting angles for attaching baffle plates. The accompanying photographs show the box divided into six compartments. The location of the angles at top of baffles and along the floor are shown; to these angles the baffle plates are welded, leaving spaces at corners for passage of water from one compartment into the adjoining ones.
5. A flat cover plate must be attached to the top of the tank. The surface angles are tapped, and the cover plate drilled to conform. Attachment is by means of brass machine screws.
6. The rear corners of the tank are outfitted with filler ports; these are equipped with long strainers reaching to the bottom of the tank and are removable for cleaning.
7. To the bottom of the tank, proper flanges must be attached for plumbing the suction lines to pumps.

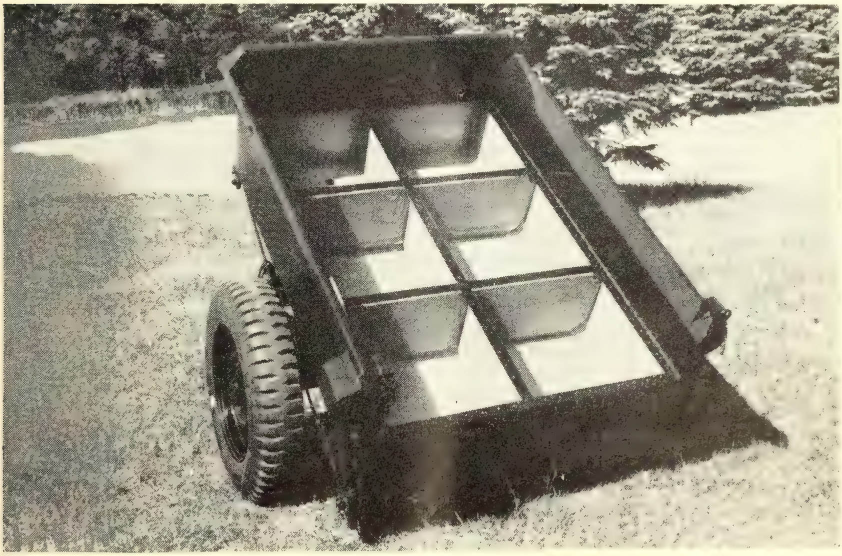

FIGURE 1.—The original trailer box is easily converted. The baffle plates contribute to improved travel characteristics, especially in the absence of springs. The tapped holes for attaching the cover plate are all located in the top surface of the angles. By removing the top plate the interior is easily accessible for repair, refinishing, or cleaning.

The removable top has proved very useful in providing access to the interior for refinishing, repair or seasonal cleaning. Figures 2 and 3 illustrate the fact that deck space is left for items which might have to be carried on top of the trailer.

The flat deck also provides a position for a power pump if desired (fig. 2). If this feature is incorporated in the outfit the unit becomes

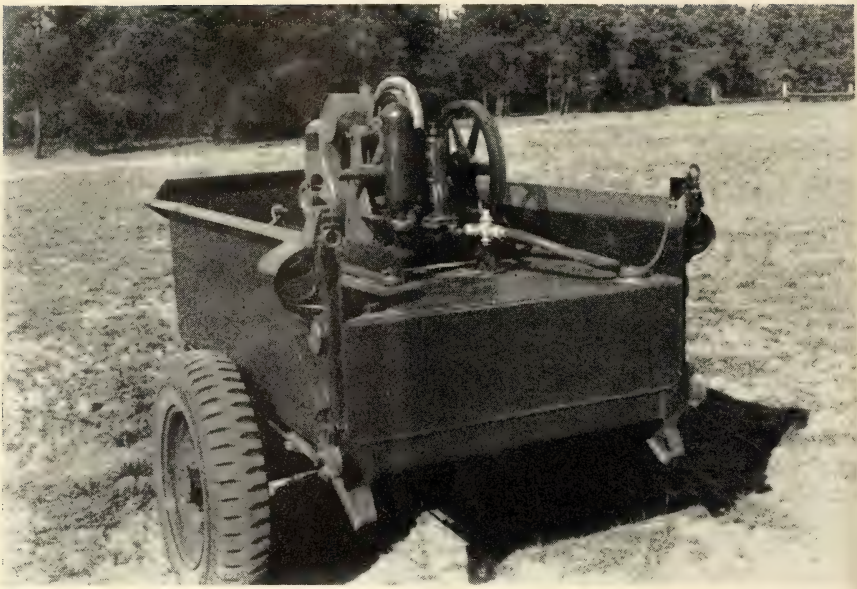

FIGURE 2.—The trailer may be mounted with a power pump on the top deck, in which case it becomes a self-contained tanker. Two filler ports equipped with strainers are provided.

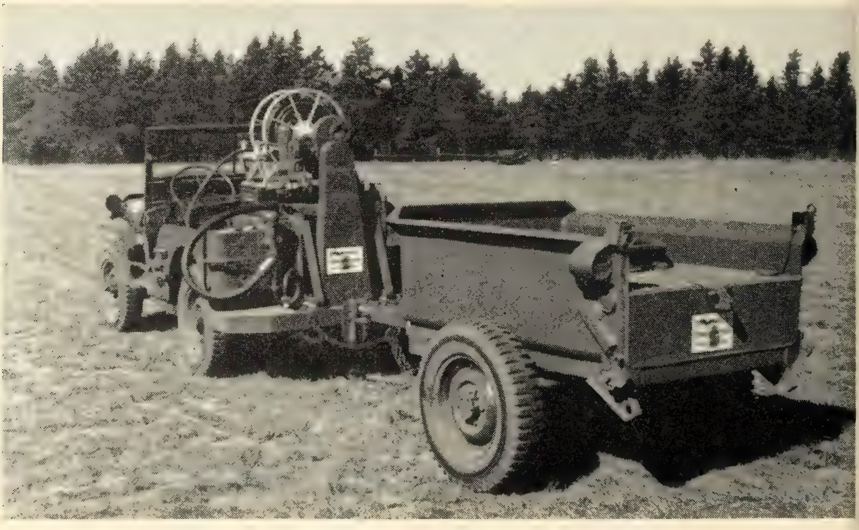

FIGURE 3.—Towed by a jeep the trailer provides 110 gallons of water in addition to that carried in the truck. If conditions of terrain become too difficult to haul the trailer in actual fire fighting, it may be dropped off at will and the water used as tank refill on the jeep truck.

a self-contained tanker, able to work behind any towing vehicle including tractors. The pump illustrated is a Bean Little Giant No. 66, capable of 400 pounds pressure and 7 gallons per minute. Used with a modern spray gun the water is employed most effectively, since

the high pressure of the stream produces a strong sweeping action in burning fuel.

If the outfit is used as a water carrier only, a wide variety of combinations is possible. One of these is illustrated with the trailer transported by a jeep (fig. 3). In this case the pump becomes part of the truck and is driven by a power take-off. The jeep is also equipped with a built-in tank of 60 gallons. If the trailer becomes awkward to transport behind a towing vehicle, it may be dropped and its water content employed as tank refills for the truck. This becomes the case in about 50 percent of the fire runs.

It will be found desirable to equip either the trailer or truck unit with a live reel and the usual tool equipment necessary to operate power pumps. One experimental assembly is illustrated; in this instance the entire reel is mounted on a cabinet containing a tool drawer (fig. 4). The entire assembly constitutes a complete unit which may be handled or mounted as one piece, either on the trailer or truck.

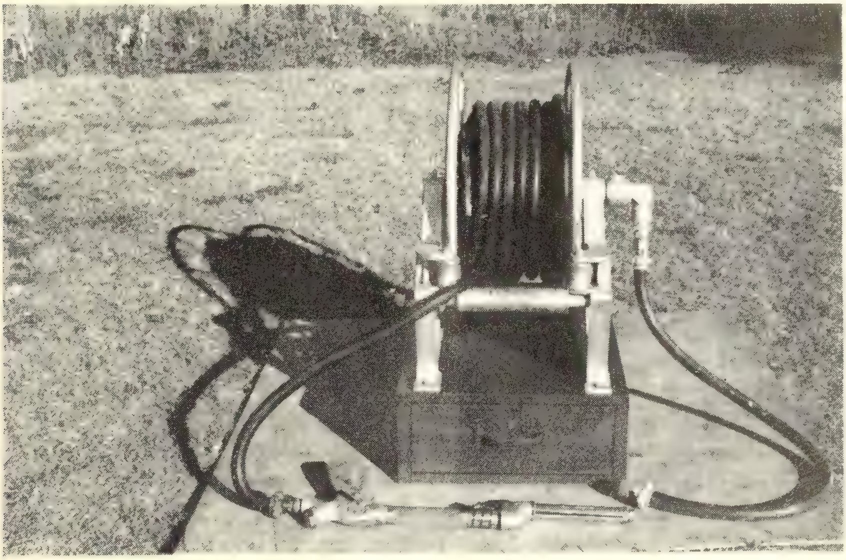

FIGURE 4.—A live reel and tool box unit developed to accompany trailers or tankers of this kind. It may be mounted as a complete assembly, either on the trailer or the truck. The tool equipment includes a complete issue of wrenches, pliers, screw driver, gaskets, hose fittings, and a variety of items required to operate and maintain power pumps.

In trailer tankers of this kind, total water capacity must be decided by the design. Capacity also depends on proposed use and assignment. In the trailer illustrated, it is limited to 110 gallons, although the original box is large enough to provide for a tank of 175 gallons without difficulty and still leave enclosed deck space for other cargo.

Total gross weight with water cargo will approximate 1,500 pounds which permits road use in Michigan without brakes.

Specifications of the original trailer are as follows:

Weight	636 pounds	Length	93½ inches
Height	45½ inches	Width	56 inches

To date, the best use of this outfit, transported by a jeep, is in fast initial attack. The use of high water pressure has been found effective and efficient in the application of small quantities of water. It has also been found that even though the trailer might not be transported behind a truck while fire is being fought, the prompt refill of tanks from the trailer tank insures immediate return of the truck to fire fighting.

In all tanker equipment the problem of refilling at water sources must be solved. In this case an ejector type of tank filler is used. It is operated by the Bean pump at a pressure of 400 pounds. Suction lift is most efficient at 15 feet or less and capacities are as follows:

Suction lift:	*Gallons per minute*
15-foot	20
10-foot	24
5-foot	28

These refill capacities are secured with an input of 6 gallons per minute at 400 pounds pressure.

Three Projects in Process at Arcadia.—The following are three of the projects in process at the Arcadia Fire Control Equipment Development Center.

Ejectors . . . Known also as eductors, injectors, tank fillers, and jet pumps. For use as quick tank fillers they indicate a possibility of filling tanks at from two to three times regular pump capacity. They can also be used for drafting from ponds with tanker up to 200 feet from water source or for drafting on lifts up to 100 feet. Eventual development may eliminate suction hose and reduce danger of pump damage when pumping dirty water.

Small hose . . . With the field trend definitely toward smaller nozzle tips and reduce flow, the use of 1-inch and 1½-inch hose for single streams becomes less necessary. Present study is in friction loss and other properties of hoses from ⅜ inch to 1 inch in linen, high-pressure, and cotton-jacketed rubber-lined. Advantages of small hose are higher allowable operating pressures, lighter weight, less storage space, longer length can be handled by a single man and hose can be had in single continuous lengths.

Back pack . . . A back-pack pump outfit of 4-gallon capacity and having a pump with 8 less parts than present units is being investigated. Advantages noted from preliminary tests include light weight, improved pump, a cost 25 percent less than present commercial models, convenient right- or left-handed use of pump without removing unit from back.—ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER, *Region 5, U. S. Forest Service.*

55-GALLON SLIP-ON PUMPER-TANKER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

The Arcadia Fire Control Equipment Development Center was assigned a project to construct a light slip-on tanker suitable for jeep and pickup installation, for use principally by patrolmen.

The use of small surplus spray rigs (reported in April and July 1948 issue of FIRE CONTROL NOTES), when other equipment was not available, indicated such a unit to be desirable. The basic specifications indicated that it be a complete self-contained unit, as light as possible, high water-weight ratio, and be equipped with a pumper unit with an output of at least 18 gallons per minute at 250 pounds per square inch.

A slip-on tanker meeting these specifications was designed and constructed, using a pumper unit which has met requirements for a light, portable outfit under specification "Portable Pumpers, U. S. F. S. R–5, Model 47, revised October, 1947."

The unit, consisting of a pump and engine and one large box mounted on a water tank (fig. 1), weighs 373 pounds without equipment, and with tank empty. Fully equipped for pumping on a fire, it weighs 950 pounds.

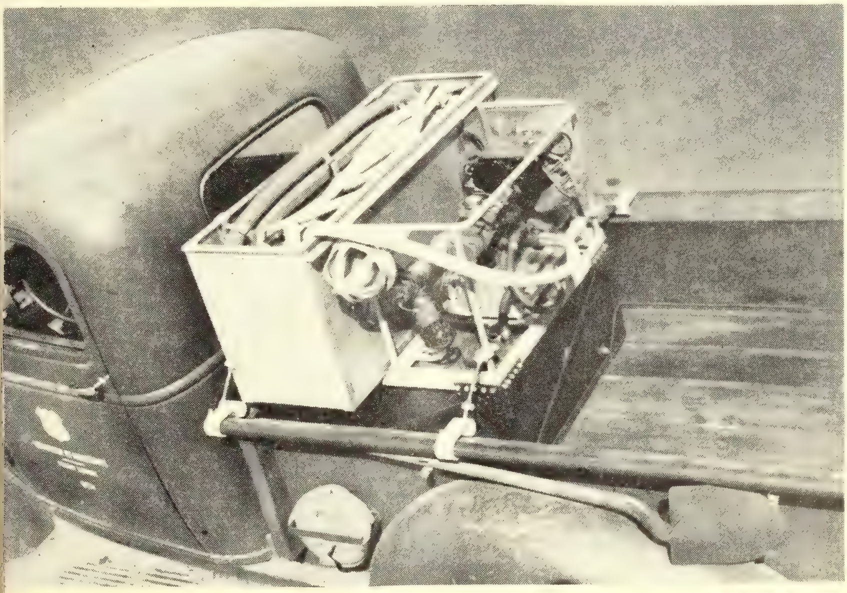

FIGURE 1.—55-gallon slip-on unit mounted in pickup.

The small positive displacement pump is powered by an air-cooled gasoline engine which is rated at 6 horsepower and 2,700 revolutions per minute. The pump and engine make a unit 24 inches long, 16¼ inches wide, and 20 inches high, weighing 96 pounds. The unit is equipped with a rope starter. Following is a table showing pump performance in gallons per minute at various discharge pressures and with 3 feet of water suction lift:

Pressure (pounds per square inch)	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

FIGURE 2.—Slip-on unit mounted in jeep.

The 55-gallon water tank is made of 14-gage aluminum alloy. It is 28½ inches wide, 32 inches long, and 14½ inches high. An aluminum box provides space for the 5-gallon gasoline tank, a tool kit, four 4-foot lengths of 1½-inch suction hose, and 200 feet of 1-inch cotton-jacketed, rubber-lined hose. Four clamps and turnbuckles provide a means for rapidly securing the unit to a jeep, weasel, or pickup bed (fig. 2).

The pumper is equipped with four folding handles for use in carrying as a portable pumper. It is mounted on two angle irons at the base, to which the pipe frame is attached. By removing four bolts and disconnecting suction and bypass lines, the pumper can be removed for portable use.

Observations and conclusions.—Based on field use for one season, a combination jeep and pickup unit is not recommended as practical. Because of the dual purpose, design compromises reduce efficiency for the pickup installation. It appears more practical to design separately for the jeep and for the pickup.

Aluminum construction used in both pumps and tank has given rouble due to electrolytic action between aluminum and chemicals in vater available in certain areas. Baffles have pulled loose at spotvelds, causing holes in tank. Hard starting and difficulty with pumps reezing can also be attributed to this cause.

When installed in a jeep bed, the aluminum tool and hose box gives he appearance of top-heavy design. Basically, the center of gravity of the loaded vehicle is sufficiently low to insure safe operation. The psychological effect on field men, however, is adverse.

The concensus of field men in several regions indicates that hose baskets, as such, are not satisfactory for general tanker use. A hose eel, preferably live, is more desirable.

Further work is scheduled for this fiscal year on the design of unit for the ½-ton pickup only. Additional work on a jeep installaion is being carried on by Region 9. For details of the unit described, efer to Specification "Slip-on Pumper-Tanker, U. S. F. S. R-5, Model 48," and Drawing F-2-03 on file at the Equipment Developnent Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

Use of Firefinder to Measure Fires.—William T. Stephenson, lookout man on Ranger Peak, San Bernardino National Forest, uses his firefinder and a table to etermine the diameter of fires.

Table 1 gives for each minute reading on the azimuth circle the diameter in eet of a fire 1 mile away. The table also gives diameters for each degree reading n the azimuth circle.

Example: To determine the diameter of a fire 8 miles away. A sight on one ide of fire reads 31°20′. The sight on opposite side of fire is 32°33′. The difference between the two readings is 1°13′; this is the width of fire in degrees and ninutes. From the table, 1° gives 92.40 feet, and 13′, 20.02 feet, a total of 12.42 feet, the diameter at 1 mile. The diameter of the fire 8 miles away is times 112.42 or 899.36 feet.

ABLE 1.—*Predetermined diameters of fires 1 mile away by minutes and degrees of angle*

inutes	Feet	Minutes	Feet	Minutes	Feet	Minutes	Feet	Degrees	Feet
	1. 54	16	24. 64	31	47. 74	46	70. 84	1	92. 40
	3. 08	17	26. 18	32	49. 28	47	72. 38	2	184. 80
	4. 62	18	27. 72	33	50. 80	48	73. 92	3	277. 20
	6. 16	19	29. 26	34	52. 36	49	75. 46	4	369. 60
	7. 70	20	30. 80	35	53. 90	50	76. 90	5	462. 00
	9. 24	21	32. 34	36	55. 44	51	78. 44	6	544. 40
	10. 78	22	33. 88	37	56. 98	52	79. 98	7	646. 80
	12. 32	23	35. 42	38	58. 52	53	81. 52	8	739. 20
	13. 86	24	36. 96	39	60. 06	54	83. 06	9	831. 60
0	15. 40	25	38. 50	40	61. 60	55	84. 60	10	924. 00
1	16. 94	26	40. 04	41	63. 14	56	86. 14		
2	18. 48	27	41. 58	42	64. 68	57	87. 68		
3	20. 02	28	43. 12	43	66. 22	58	89. 22		
4	21. 56	29	44. 66	44	67. 76	59	90. 76		
5	23. 10	30	46. 20	45	69. 30	60	92. 40		

THE TABER BRUSH CUTTER

W. S. Taber

State Forester, Delaware Forestry Department

Two brush cutters suitable for Coastal Plain terrain or similar soil and vegetative conditions have been constructed, specifically for the Clarkaire tractor, by the Delaware Forestry Department. One of the brush cutters is permanently attached to the pusher arms or A-frame (fig. 1), the second is bolted on at three points (fig. 2).

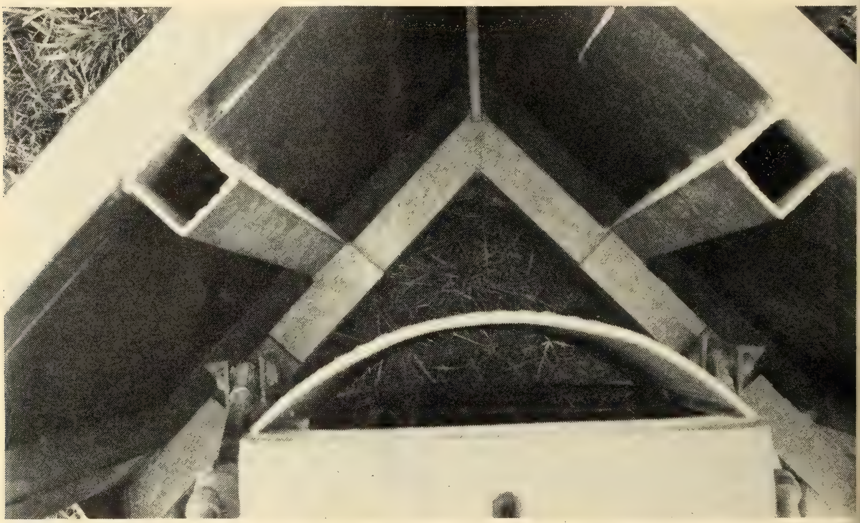

Figure 1.—Taber brush cutter permanently attached to A-frame. (Photographs by Delaware State Forestry Department.)

The Clarkaire tractor has sufficient power to cut off live trees up to the protruding width of the blade which in our case is 3½ inches. By making a pass on either side of a larger tree, trees up to 7 inches butt diameter may be severed.

The brush cutter uses hard steel-backed paper knives ⅞ inch thick and 5½ inches wide. The knives are welded to a framework of 3- by 3- by $\frac{3}{16}$-inch cold-drawn seamless tubing and 16-gage sheet iron. This framework is welded to the A-frame or provision is made for bolting. The vertical nose is also made from a paper knife and serves to cut briers (fig. 3). Angle irons, 3 by 3 by ¼ inches, are welded to the posts, knives, and sheet iron for further strengthening. A 3-inch skid shoe at the point of the bottom knife keeps it from digging. Cost of construction per brush cutter is $20 for paper knives, $35 for square tubing for posts and top rail, $15 for 16-gage sheet iron and other odds and ends, and $70 for welding.

The radiator guard illustrated in figure 1 is made by splitting a perforated hammer mill screen in half, welding the halves in the center, and skip-welding the guard to the outer radiator shell. Screen material is $\frac{3}{16}$ or ¼-inch thick and is reinforced with ½-inch iron round rods at top and bottom. Cost is $10.

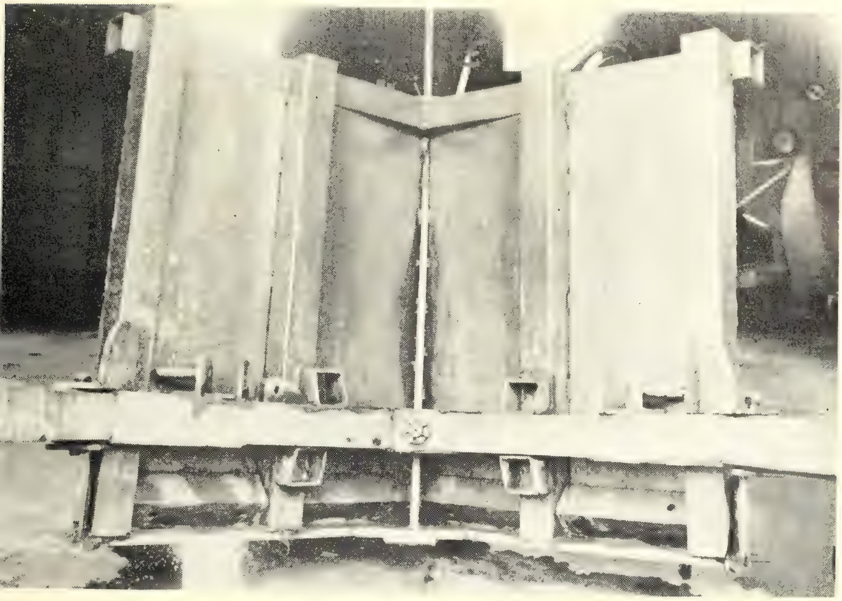

FIGURE 2.—Slip-on brush cutter with A-frame in place; bolt in center is a 1-inch clevis bolt which straddles vertical knife.

FIGURE 3.—Taber brush cutter depends on sliding action of knives. Note slant of vertical knife.

250-GALLON SLIP-ON PUMPER-TANKER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

Recent trends in the Forest Service have been toward the use of slip-on and demountable tankers to replace conventional fire trucks. In general, fire trucks, whether in use by the Forest Service, State, county, or city fire departments, become obsolete even though actual vehicle mileage is low. The solution of this problem, particularly for those areas not having a year-round fire season, appears to be slip-on pumper-tankers. These can be readily transferred to any truck and, as a result, maximum utilization of vehicles is obtained. A slip-on unit of this type, built in 1948 for stakeside trucks in the 13,500 gross-vehicular-weight class, is shown in figure 1. The improved unit shown in figure 2 was built in the spring of 1949.

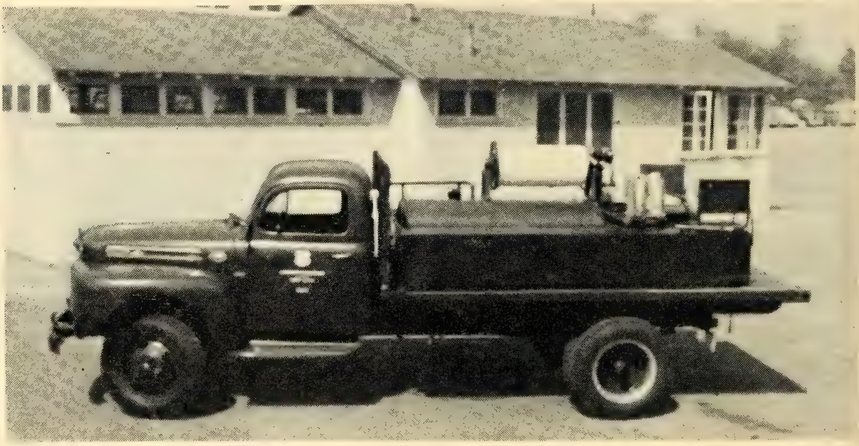

FIGURE 1.—Pumper-tanker unit built in 1948.

The 1949 unit consists of a tank; pumper; live hose reel; tool, hose, radio, and equipment boxes; and hose basket mounted on a skid frame. The unit can be made self-contained, having as extras its own batteries, lighting system, siren, spotlight, and red light. It is fastened to the chassis frame of the vehicle with four J-bolts. Seating accommodations for two crew men are provided.

The over-all dimensions of the unit are 10 feet 11 inches long, 6 feet 7 inches wide, 2 feet 5 inches high, to top of fill spout. The empty weight, without water, hose or fire tools, is 2,095 pounds. Filled, equipped with all fire-fighting equipment listed further in this article, and including two crew men in the seats, the unit weighs 5,290 pounds.

The pumper unit used has a rated capacity of 30 gallons per minute at 250 pounds per square inch, 45 gallons per minute at free discharge, and 23 gallons per minute at a maximum pressure of 340 pounds per square inch. It is a positive displacement gear type, driven by a 10-

horsepower, opposed twin cylinder, air-cooled, four-stroke cycle engine. The unit is electrically started, being equipped with a 12-volt tarter generator system. Provision is made for emergency rope tart. The pumper unit is also available with rope start only. The pace allotted for the pumper is sufficient to allow for the installation of other types of pumpers, such as higher or lower pressure gear, piston, or centrifugal type units in the comparative weight class. The pumper unit used weighs 192 pounds.

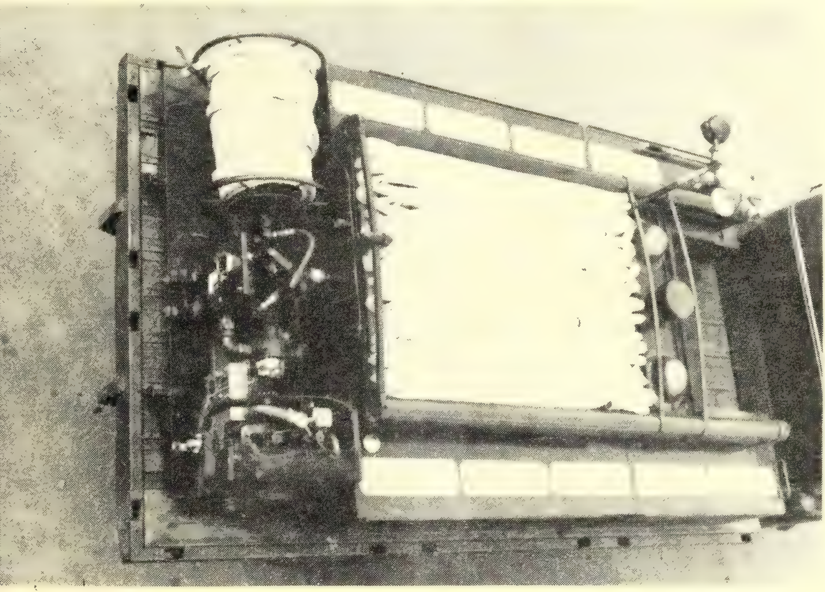

FIGURE 2.—Pumper-tanker unit built in 1949.

The 250-gallon tank, constructed of 14-gage black iron, is divided nto three compartments by two transverse baffles. For ease in fabriation, cleaning, and painting, the entire top cover is removable. The tank is 6 feet long, 3 feet wide, and 22 inches high. The hingeapped fill spout has a 16-mesh strainer. Other tank openings are ½-inch for suction and fill, and 1-inch for drain, vent, and relief alve return. After fabrication and testing, the interior of the tank s sandblasted and given three coats of a sanitary rust preventive aint. Gage cocks, with plastic tubing, are provided at the rear end f the tank to show the water level.

All operating valves and piping are mounted as a single assembly djacent to the pump. Valve handles, pressure regulator and presure gage are mounted on a panel board. Suction connection from ump and tank to pipe assembly is by means of 1½-inch hose. A 16-nesh strainer is provided in the overboard draft line. A combinaion panel and red light is mounted on top of panel.

The high-pressure hose reel will accommodate 250 feet of 1-inch otton-jacketed rubber-lined or ¾-inch high-pressure hose. Hose reel s constructed to withstand an operating pressure of 800 pounds per quare inch. The reel is equipped with an eccentric type quick-throw

friction drag brake, and a geared crank for winding in the hose. Figure 3 is a closeup of the rear, showing pumper, control panel, and reel.

There are four equipment boxes, two mounted on each side of the tank. They are mounted on T-iron outriggers fastened to the main frame. If desired, either or both of the forward boxes could be replaced with hose reels. On the right side (fig. 4) the forward box has been left empty for use in carying crew's duffel, additional hose, or equipment. The rear box is used to carry fire tools, flashlights, fuses, etc. The fuel tank for the pumper is installed in this box.

On the left side (fig. 5) the forward box is used to house the storage batteries and for the installation of radio equipment. The rear box is used to store nozzles, strainers, adapters, and additional hose.

At the forward end of the unit, between the boxes, two crew seats are installed. In this position the men are fully protected by the vehicle cab in front and the boxes on the side. In most vehicles a small amount of forward vision is available through the rear window of the cab. As shown in figure 6, the seats are low and, in this position, it is unnecesary to provide safety straps for the crew. Space is available between the back of the seats and the front of the tank to accommodate four 1-gallon canteens. Design revision scheduled for this fiscal year will provide alternate design to accommodate three men.

Four 8-foot tubes, two to the side, are mounted on the tops of the equipment boxes. These are for storage of the suction hose. The 1½-inch suction hose is easily removed from the forward end of the unit. These tubes also form the sides of the hose basket on the top of the tank.

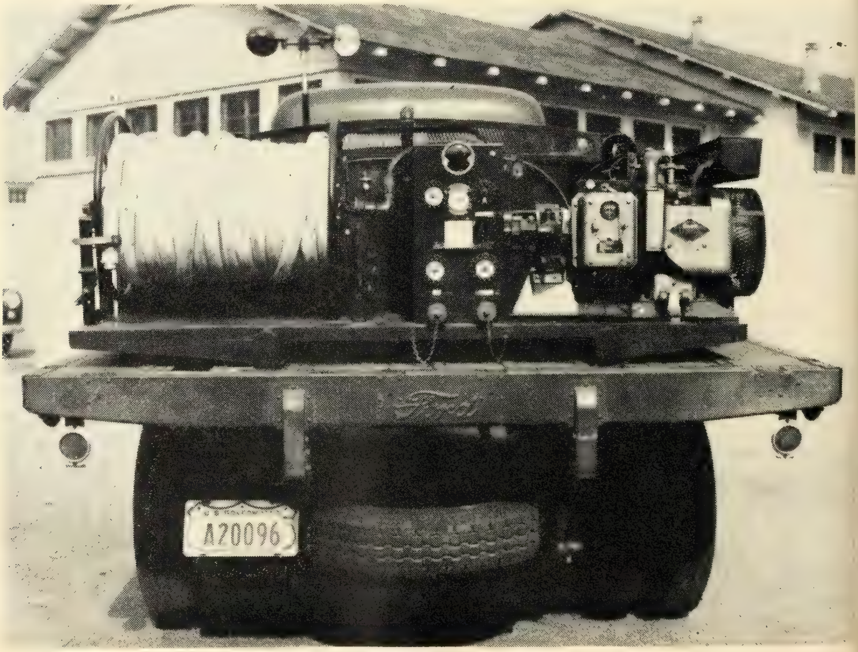

FIGURE 3.—Slip-on unit showing live reel, control panel, and pumper.

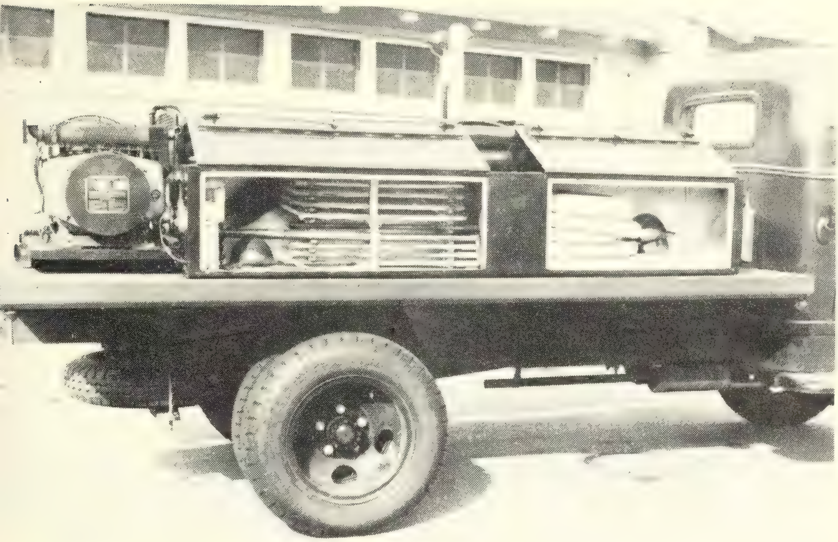

FIGURE 4.—Equipment boxes on right side of unit.

The top hose basket (fig. 2) accommodates 250 feet of 1½-inch cotton-jacketed, rubber-lined (CJRL) hose, laid in accordion fashion. Expanded metal on angle-iron frames is used to form the ends of the basket. Oak slats are installed over the tank to serve as the basket bottom and to allow for air circulation under the hose.

For maximum safety, adequate guards have been installed over engine flywheel and the muffler. Nonskid surfacing has been applied to the tops of the equipment boxes. Grab handle has been installed on top of box to facilitate boarding and leaving vehicle. A red spotlight and a white spotlight have been mounted on an extension pole at the front of the tank. These lights swing through 360° independently and can be used for warning, as well as locating items in the vicinity of the vehicle. By means of the extension pole, the lights can be raised sufficiently to shine forward over the cab of the vehicle. The siren is operated by means of remote cable and push button controls mounted in the truck cab.

To facilitate engine maintenance and operation, brass plates containing necessary instructions are mounted on pumper and valve panel. Valves are further identified by numbering, to tie them in to the operating instructions. All parts of the unit used in normal operation that cannot be reached from the ground are accessible from the space in front of the crew seats.

This unit is intended for use as a primary first attack tanker operated by a crew of four men. It carries sufficient hand tools to outfit a crew of at least eight men.

In April 1949 bids were let by Region 5 for construction of 12 of these units. The low bids were approximately $1,350 for the unit, less pumper, and $575 for the pumper unit. Hose, fire tools, backpack pump, and other equipment cost approximately $750.

The list of equipment furnished for the unit is as follows:

1 Set of tools for engine and pump.
1 Back-pack pump, complete.
4 Lengths of suction hose, 1½-inch (8-foot lengths).
1 Strainer for suction hose.
1 First aid kit.
4 Hats, protective.
1 Siamese valve, 1½-inch.
11 Lengths hose, CJRL, 1-inch (50-foot lengths).
10 Lengths hose, CJRL, 1½-inch (50-foot lengths).
3 Shovels, size 0.
2 Axes, double-bitted.
2 Brush hooks.
1 Fire extinguisher, 1½-quart.
1 Wrecking bar.
1 Bolt cutter.
2 Garden hose nozzles.
4 Spanner wrenches.
2 McLeod tools.
2 Pulaskis.
4 1-gallon canteens.
1 Automatic check and bleeder valve.
2 Nozzles, shutoff, twin tip, with fog and solid stream tips.
3 1½-inch to 1-inch adapters.

This unit (fig. 2), being the second model of this class, shows considerable improvement over the original unit (fig. 1). With the experience gained in two seasons' use of this equipment, we are preparing final plans and specifications which will be but slightly improved over this 1949 model. Alternate pumper and piping layouts are being prepared. A new live hose reel is being planned, to facilitate paying out of the hose to the sides of the vehicle. Crew seats are being redesigned to accommodate three men. We are also working on the design of a larger tank for use in those areas where mountain

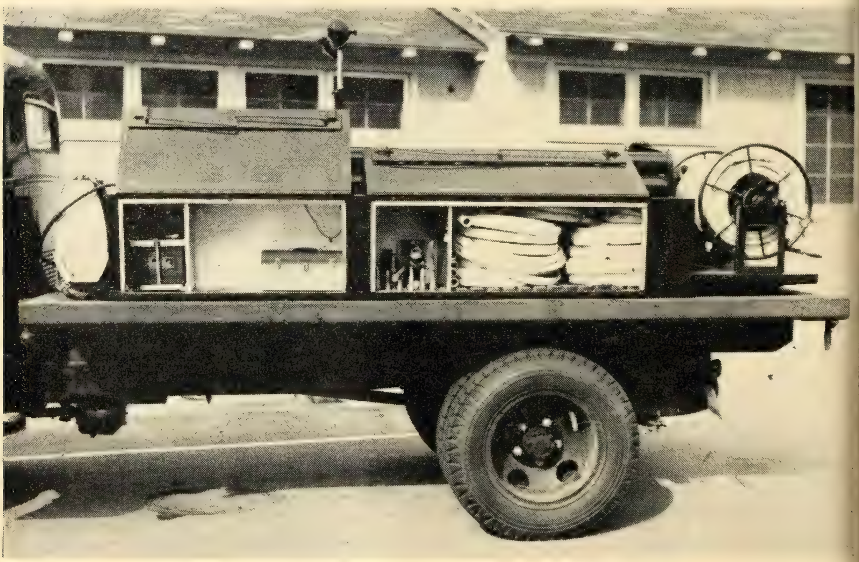

FIGURE 5.—Equipment boxes on left side of unit.

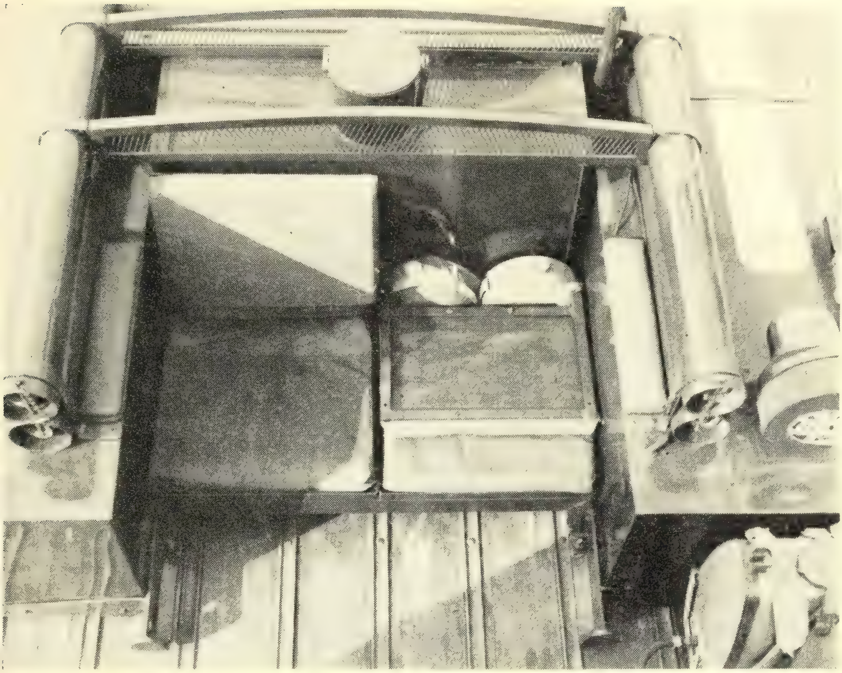

FIGURE 6.—Front end of unit showing seats for two men, space behind seats for canteens, and the four 8-foot tubes for storing suction hose.

grades and off-road terrain are not as severe as they are in the western regions, and loading to the maximum gross vehicle rating can be made without sacrificing speed and maneuverability.

The construction of this 250-gallon slip-on pumper-tanker is covered under Arcadia Fire Control Equipment Development Center Drawings Nos. F–17–01, F–17–02, F–17–03, F–17–04, F–17–05, and F–1–10; and Specifications "1½-ton Slip-on Tanker, U. S. F. S. R–5, Model 49," and "Live Hose Reel, U. S. F. S. R–5, Model 48, revised March 4, 1949, Size 3." The pumper unit is covered by Specification "Portable Pumper, U. S. F. S. R–5, Model 49 (30 gpm at 250 psi, 4-stroke cycle gasoline engine, battery ignition, electric start)." Plans and specifications are available at the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

MECHANIZED FIRE FIGHTING ON A GULF COAST RANGER DISTRICT

Russell E. Rea

Assistant Chief of Fire Control, Region 8, U. S. Forest Service

The advantages from applying mechanized fire equipment to the fire suppression job are becoming more and more evident. It has reached a high stage of development in the coastal flatwoods belt stretching from North Carolina to Florida and around the Gulf Coast to Texas. Some of the results can best be shown by analysis of its use on a typical coastal ranger district. Developments on the Biloxi Ranger District of the Mississippi National Forests offer a measurable example.

One hundred fires occurred on this District during the period January 1 through September 15, 1949. Total acreage burned was 1,019 acres, an average of about 10 acres per fire. Total length of line constructed to control the 100 fires was 4,357 chains; 3,826 chains, or about 88 percent of this line, were constructed with mechanized equipment.

The Biloxi Ranger District has a protection area of about 200,000 acres. It is predominantly flatwoods type with longleaf-slash pine and a fast burning ground cover of grass and underbrush. Fire occurrence and area burned during the period January 1 through September 15 are as follows for 1945–49:

Year:	*Fires (number)*	*Total acreage burned (acres)*	*Average size of fires (acres)*
1945	90	4,800	53
1946	288	6,107	21
1947	295	6,594	22
1948	158	3,747	24
1949	100	1,019	10

Decreasing acreage subsequent to 1947 directly reflects the development of mechanized equipment. This ranger district has six Ranger Pal plows, one Mathis plow, and one Dodge power wagon tanker. Ranger Pal plows are transported on 1½-ton stake trucks. The Mathis plow is transported by semitrailer.

Both the Ranger Pal and Mathis tractor-plow outfits are described in detail in the U. S. Forest Service Fire Control Equipment Handbook. The Dodge power wagon is equipped with a 180-gallon water tank and package unit power pump. All transport equipment is equipped with 2-way mobile FM radio.

Mechanized equipment has largely displaced manpower on this ranger district. Individual fire records for the 100 fires in 1949 show that the maximum number of men used on any one fire was 15. Thirty-eight fires were handled with only 3-man crews and the average number of men per fire was 5. Ninety-eight of the 100 fires were of incendiary origin, varying in the number of sets from 1 to 18. The average number of sets per fire was 3. Forty-one fires were recorded as having only one set.

Tractor-plow outfits are strategically distributed over the protection area to facilitate quick attack. Small fires are handled with one outfit; large fires or ones with multiple sets are handled with two or more outfits. Actual use of equipment on the 100 fires is as follows:

Equipment used:	Number of fires
1 plow	53
2 plows	26
3 plows	3
4 plows	1
1 power wagon tanker	3
1 plow and tanker	5
2 plows and tanker	3
Hand tools only	6
	100

Occurrence of fires by fire danger classes is shown below. The longleaf-slash pine danger meter, used on this area, rates fire danger in five classes: Class 1 is practically no fire danger, Class 2 low, Class 3 moderate, Class 4 high, and Class 5 extreme.

Class fire day:	Fire occurrence
1	0
2	8
3	43
4	37
5	12
	100

The 6 fires suppressed by hand tools were handled when conditions did not necessitate mechanized equipment. Total area burned by these 6 fires was 4 acres. Ninety-one fires were suppressed at less than 25 acres each. Of the 9 fires exceeding 25 acres in area, only one exceeded 100 acres in size, having a total area of 126 acres.

These figures tell their own story of reducing the average size of fire from 53 acres to 10 acres in a 5-year period. It should also be added that mechanized equipment is only as effective as the skill of the operators and crews who use it. Experienced and well-trained crews and an alert and well-trained fire dispatcher are necessary in order to handle equipment in the manner required to produce this excellent fire suppression record.

PNEUMATIC BACK-PACK FLAME THROWER

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

A pneumatic back-pack flame thrower, using Diesel oil, has recently been designed and submitted for tests to the Arcadia Fire Control Equipment Development Center. It is a result of service requirements suggested to manufacturers for the construction of a flame thrower using straight Diesel oil, that would operate satisfactorily at pressures between 40 to 100 pounds per square inch.

In the past, the difficulty encountered with Diesel flame throwers has been in hand pumping the tank to high working pressure and in maintaining pressures required to produce the desired flame. Previous units would not operate satisfactorily at pressures under 70 pounds per square inch when using straight Diesel oil. In order to overcome the need for high pressures a mixed fuel containing part Diesel oil and part kerosene was used. This allowed for operation at from 40 to 60 pounds per square inch. However, the length of flame projection with the mixed fuel was approximately 50 percent of that obtained with straight Diesel oil. Variations in the mixture of oil and kerosene and the possibility of a dangerous oil gasoline mixture made the units undesirable. The further requirement of a separate fuel and containers further complicated the use of this type of equipment. Also the firing gun became too hot when in continuous operation and its use was restricted to intermittent firing only.

The new back-pack flame thrower consists of a tank, air pump, firing gun, shoulder straps, hose and hose connections, filler cap and pressure gage (fig. 1).

The unit fits into a space 10 inches square and 25 inches high. It weighs 18¼ pounds empty and 47¼ pounds with the 4-gallon tank full of Diesel oil.

The tank, which is 9 inches in diameter and 24 inches high, is made of 61 ST aluminum alloy sheet welded to sand cast aluminum head and base, and is tested to 250 pounds per square inch. The top head of the tank is constructed so as to prevent complete filling of the tank with oil, thus maintaining a safe minimum air chamber.

The firing gun which is 24¼ inches long, consists of an aluminum alloy tube having a pistol grip type of handle with a trigger-operated nozzle valve on one end an a flame igniter cap with asbestos wicking secured in the base on the other.

The hose connecting the firing gun to the fuel tank is provided with a coupling of the quick-disconnect instant shut-off type.

To provide a rapid and easy means of pumping up the fuel tank, a pneumatic tire type pump, with a 20½-inch stroke and 1⅜-inch diameter, is attached on the outside of tank by means of metal bands.

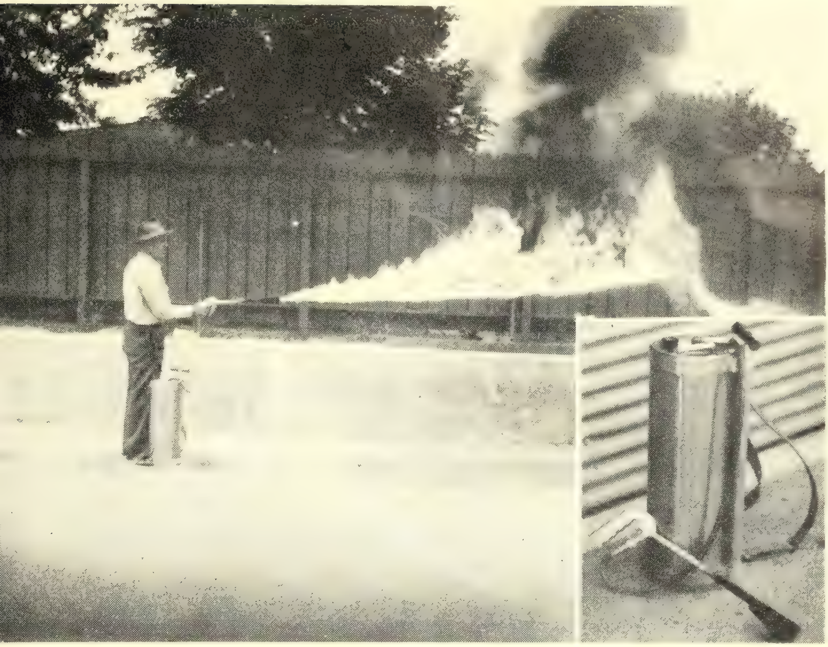

FIGURE 1.—Pneumatic back-pack flame thrower.

)-rings to which back-pack straps can be attached, are welded onto hese bands.

Tests were conducted to determine: (1) Length of time and the efort required in pumping the tank up to working pressures; (2) rate f pressure drop when operating; (3) rate of fuel consumption; (4) mount of unburned fuel deposited on the forest fuel to sustain fire; nd (5) length of flame projection at various pressures.

Test results were as follows:

(1) After the tank had been filled with Diesel oil to the prescribed evel (4 gallons), 57 strokes of the pump were required to produce 50 ounds per square inch pressure. One hundred pounds per square inch ressure was obtained by 122 strokes in 1 minute and 50 seconds, withut undue effort.

(2) After a pressure of 100 pounds per square inch was obtained in he tank, the flame thrower was operated for 4 minutes before the presure decreased to 40 pounds. At this point 2 gallons of oil had been ischarged.

(3) Fuel was consumed at the rate of 0.6 gallon per minute at presures of 80 to 100 pounds per square inch, 0.53 gallon at 60 to 80 pounds, nd 0.45 gallon at 40 to 60 pounds.

(4) One advantage of a Diesel flame thrower is that all the fuel il is not consumed in flight and sufficient is deposited on the surface o maintain the flame. At 100 pounds per square inch pressure, pracically all of the Diesel oil is consumed in flight if flame is allowed to ravel its maximum distance. If directed on objects 12 to 14 feet disant, however, some Diesel oil is deposited, which, coupled with a hot

flame, produces good ignition. At 80 pounds per square inch a noticeable amount is deposited, and at 40 pounds sufficient oil remains on the forest cover to maintain the flame even under adverse burning conditions. Flame can be maintained by the torch down to a pressure of 20 pounds per square inch.

(5) Length of flame projection for various pressures is as follows:

Pressure (pounds per square inch)	*Approximate distance (feet)*
100	12–20
80	10–14
60	8–10
50	6–8
40	6–8
20	2–4

The following conclusions were made:

This flame thrower can be used for continuous firing, completely discharging a tank of fuel, without the firing gun becoming excessively hot.

An adequate air pump provides a rapid and easy means of supplying sufficient working pressures.

Diesel oil alone can be used to project a flame 6 to 20 feet at pressures from 40 to 100 pounds per square inch, respectively.

The 4-gallon tank of Diesel fuel will provide constant firing for 6 or 7 minutes at 80 to 100 pounds pressure or for 9 to 10 minutes at 40 to 60 pounds pressure.

When burning conditions are such that a deposit of oil to aid burning is not required this torch can be used as a drip or orchard torch. Under this condition only enough oil is discharged to maintain flame on the asbestos igniter pad of the flame tip. This requires a short blast every minute to maintain flame on wick, and under this condition of operation, the unit has sufficient capacity for from 2 to 4 hours of operation on a single filling.

From test operations it appears that the most desirable operating range is from 40 to 60 pounds pressure. At this pressure range flame projection is adequate, flame characteristics are good, and sufficient fuel is deposited to help sustain fire.

The unit as a whole is lightweight, sturdy, and safe.

Of the pneumatic flame throwers tested to date this unit most nearly approaches the desired operating characteristics for this type of equipment. The present cost of the unit f.o.b. Arcadia is approximately $45. Further information on this unit may be obtained from the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

THE ACTUARIAL METHOD OF FIRE SUPPRESSION PLANNING AS APPLIED TO TANKER DISTRIBUTION

RALPH L. HAND

Division of Fire Control, Region 1, U. S. Forest Service

The Region 1 fire suppression plan is somewhat of a new departure n that it is based primarily on actuarial principles. The object is o determine the probable load in terms of the expected use of manower, overhead, power equipment, transportation, warehousing, and ll other elements that are necessary to do a satisfactory, economical ob of fire suppression. The use of mass statistics has been eliminated n favor of the individual fire analysis and the calculation of matheatical betting odds has been selected in preference to the timeonored employment of averages which has long since proved meaningless in dealing with the various combinations of unpredictable onditions that make up the fire problem.

Three years ago, at the beginning of the planning project, it was ecided that a cross-section sampling of 6 representative years of the revious 16 would be used in the individual fire analysis; the reason eing that a long continuous run would be too costly and require too uch time. This idea proved erroneous and the following year saw he conclusion of a 16-year run involving some 23,000 individual fires ith no more than a couple of weeks required for the analysis on each ndividual forest. In this analysis, a post mortem was conducted n every fire—not to discover errors in the action as taken—but to econstruct each particular fire in the light of the present day as egards physical conditions, policies, and a realistic view of the huan element. Each fire was considered as to the practicability of sing bulldozers, tankers, chain saws, trenchers, pumpers, smoke jumprs, or any other special equipment or techniques of suppression. n each instance where a fire was placed in a special category, certain nformation was calculated and recorded. This included time from he nearest logical base; percentage of line that could be machine uilt; and reduction in manpower, perimeter, and time of control by eason of the application of special equipment or methods.

The value of the analysis increases in direct proportion to the knowldge and practicability of those making the decisions and to maintain onsistently high standards it is necessary to insist that top fire conrol men from each forest be given a leading part in the planning for heir unit. To insure uniformity, a fire planning specialist from the egional office likewise participates on every unit. Obviously, it is ecessary to eliminate from the record those fires in which the specific ause no longer exists in that particular area.

The application of the findings, as determined from the analysis, requires separate treatment for each of the various categories and each has its peculiar problems. The Region 1 Tanker Plan is used to illustrate the planning principles, mainly because the practical application of this plan has progressed somewhat farther in this than in planning other elements. The tanker fire problem is largely localized, and the assignment of this type of equipment relatively cheap. There are no serious problems of interforest assignment or costly transport considerations as with bulldozers, for example.

THE TANKER PLAN

The tanker plan is one of the major sections of the Region 1 Fire Suppression Plan. It was designed for the purpose of determining the extent to which tankers and all types of water-carrying equipment are needed in the region, their proper distribution, and the economy of their use compared to other fire control methods. It evaluates the problem by localized areas and determines priorities of the many prospective bases from such factors as probable occurrence of fires on which tankers should be used; volume and dispersion of fast-spreading fuels; degree of vulnerability of the area to damaging fires; accessibility to water-carrying equipment; recent occurrence trends and probable future increase or reduction in hazards.

The plan is to be used in the transfer and assignment of tankers and water carriers and as a guide in directing new developments and purchases. It provides a method by which tanker production records can be kept and used to determine the amount that we can afford to invest in this type of firefighting equipment.

THE ANALYSIS

The expectancy in rate of occurrence and seasonal duration and the hour-control data from the various bases was determined by means of the analysis of individual fires which resulted in the classification of 3,088 tanker chances out of a total of more than 23,000 fires.

It is realized that occurrence, even when adjusted to meet changed conditions, and with full consideration for recent trends, is but a single factor. The fuels that exist within those areas that are accessible to tanker equipment—the potential hazards introduced by either dense concentrations or widespread areas of fast-spreading types are at least equal if not more important, according to the degree in which they add to the possibility of costly and damaging fires. Maps were prepared by those forests that had considerable areas of slash, outlining them in as much detail as possible, and this data was supplemented by specific information gained from those individuals who had intimate knowledge of actual conditions on the ground. Smelter-fume, bug, disease, blow-down, and frost-kill were treated the same way, to the extent that they affected the situation regarding tanker use. Extensive grass areas, particularly cheatgrass slopes, were given full consideration with the greatest emphasis on potential damage rather than probable burned area.

Accessibility was determined mainly by the study of "tanker road tracings" which outline the usable roads within those areas of appreciable man-caused fire occurrence and indicate the amount of operable area. Also, time estimates were made for each individual tanker fire in relation to specified bases.

PROSPECTIVE TANKER BASE RATING SYSTEM

Add the numerical ratings from each category below to determine the final combined rating.

Occurrence.—Rate: Normal expectancy in number of fires per year.

Trend: Pronounced up or downward recent trends expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate according to degree.

Heavy Fuels.—Rate: Expressed as 1, 2, 4, and 8, for low, medium, high, and extreme, in conformity with the progression used in Region 1 in all phases of fire planning. Emphasis placed on probability of costly and damaging fires that might occur from delayed action, rather than danger of fires starting in such areas, although both factors are considered.

Trend: Best judgment available as to prospects of the immediate future expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate.

Grass fuels.—Expressed directly as 1, 2, 3, or 4, to represent low, medium, high, and extreme. In this case, too, potential cost and damage is given the edge over prospect of fires starting in such fuels.

Accessibility.—Road: Rating of 1 or 2 given according to degree of accessibility as indicated by extensiveness of the road network to cover the danger areas.

Nonroad: Rated 1 or 2 additional to show value of the base where four-wheel-drive equipment can cover areas beyond the road system.

Hour control.—Thirty-minute and one-hour control given a rating of 1 each, if 50 percent of the tanker fires allocated to the base can be reached in 30 minutes; 90 percent in 1 hour.

CLASSIFICATION OF TANKER BASES

Prospective tanker bases are grouped in four major categories as follows:

Class A or primary base.—Must be of sufficient importance that the combined occurrence, hazard, and risk warrants assignment of a high-grade, standby unit, designed as a single-purpose fire truck. Numerical rating 15+.

Class B or secondary base.—Of lesser importance than class A as determined by rating of occurrence, fuels, potential cost and damage, and other pertinent factors, but still justifies assignment of second-rate standby or first-class demountable equipment. Numerical rating 11 to 14.

Class C or utility base.—Rates below class B but still justified for tanker equipment that can be developed at moderate cost and used in combination with other activities in the out-of-fire season. Numerical rating 7 to 10.

Class D or provisional base.—Lowest rated base. Must justify assignment of water-carrying equipment in combination with need for regular transportation of fire-goers. Numerical rating 5 and 6.

The above classifications are for the purpose of grouping bases according to relative importance. Mechanical standards for tankers regarding speed, power, water capacity, etc., are another matter and should not be confused with the base categories. While most primary or class A bases will justify assignment of a prime, standby tanker, it does not necessarily follow that all grades of equipment will fall in line with the base assignments. A few relatively low rated class C bases may require heavy-duty equipment because of the nature of fuels, while other higher rated bases may warrant low-capacity, dual-use units. Four-wheel versus conventional drive is also a matter of efficiency according to the nature of the area covered by the particular base and is in no way connected with the importance as determined from the numerical rating.

On the above basis, Region 1 analyzed 105 prospective tanker bases of which 65 were given ratings of 5 or over. Fourteen made the primary, 17 the secondary, 24 the utility, and 10 the provisional grade. Seventeen tankers have been assigned since the initial rating was completed and it is expected that 9 more will be placed next spring.

A continuation of the analysis to cover three more years (1947, 1948, and 1949) will be completed this winter at a cost of approximately 3 man-days per forest and all bases will be rerated according to the latest findings. Thereafter, it is expected that the recalculation and rating will be done annually in order to keep abreast of changes in conditions and be assured of the best possible distribution of power equipment and specialized services.

Volume 11 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

NEW FIRE PUMPERS TESTED

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

In accordance with the procedure adopted for qualifying pumps s suited for forest fire service, the Arcadia Fire Control Equipment)evelopment Center has conducted performance tests on the three ortable pumps described below.

UNIT 1

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specication revised October 1947), consists of a pump, engine, base, and arrying handles (fig. 1). It has a dry weight of 96 pounds, and its ver-all dimensions are 24 inches long, 16½ inches wide, and 20 ıches high.

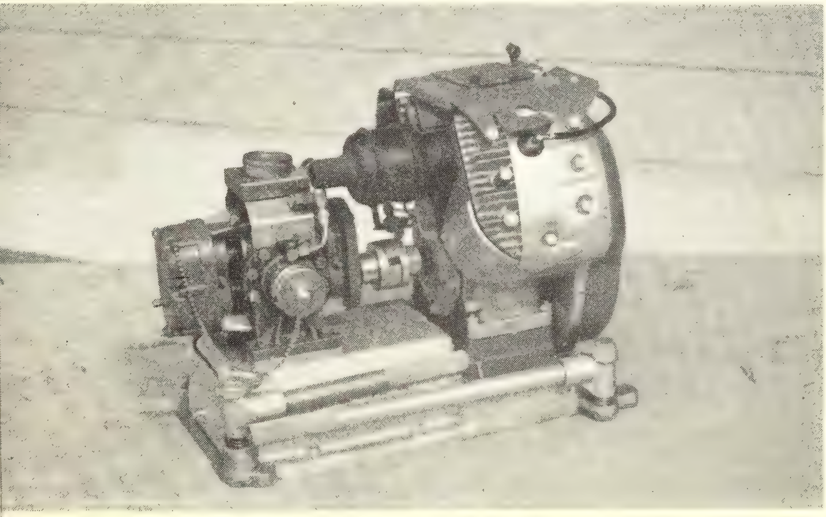

FIGURE 1.—Unit 1: U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance ratings with 3-foot suction lift are as follows:

ischarge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

The engine is a single cylinder, air-cooled, 4-stroke cycle gasoline type, rated 6 horsepower at 2,700 revolutions per minute (r. p. m.), and is equipped for rope starting. Ignition is by an impulse type magneto. Fuel used is commercial grade gasoline of approximately 70 octane supplied from an auxiliary tank by fuel pump. Fuel consumption is approximately 0.5 gallon per hour when operating at normal conditions of 18 gallons per minute (g. p. m.), 250 pounds per square inch (p. s. i.), and 2,900 r. p. m.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 3 pints.

The pump is a positive displacement gear type with pilot gears. This particular model has aluminum end cases, monel metal wear plates, and bronze impellers on stainless steel shafts. Connection of the pump to engine is direct through a flexible coupling.

Standard accessories include the following:

- Built-in tool compartment in base.
- Guard plate on which engine controls are mounted.
- Pressure gage, 0–500 p. s. i.
- 1 gasoline tank, 4-gallon.
- 1 gasoline hose, 5-foot.
- 2 starter ropes.
- 1 oil measure.
- 1 grease gun.
- 1 can bearing grease.
- 1 spark plug (extra).
- 1 spark plug wrench.
- 1 point feeler gage.
- 1 packing gland wrench.
- 1 pliers, 8-inch.
- 1 screw driver, 6-inch.
- 1 crescent wrench, 6-inch.
- 1 crescent wrench, 8-inch.
- 2 spanner wrenches, forestry lug.

Performance of this pumper compared with the specifications, revised October 1947, as follows:

Specification:	*Test results*
Maximum weight, less accessories: 100 pounds	96 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: not less than 20 inches Hg. (mercury) with unit dry and at governed normal r. p. m. specified by manufacturer.	20 inches Hg.
Vacuum after 100 hours: not less than 15 inches Hg. with unit dry and at governed normal r. p. m. specified by manufacturer.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. with 3-foot suction lift and at governed normal r. p. m. specified by manufacturer.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i. with 3-foot suction lift and full throttle.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i. with 3-foot suction lift and full throttle.	16.6 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. San Francisco, was $528 as of June 1946.

UNIT 2

Subsequent investigation toward securing a more economical unit in the same performance class has resulted in the manufacture of a cheaper model with identical performance characteristics (fig. 2).

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specifi-
ation revised July 7, 1949), is essentially the same as that shown in
igure 1. The main differences are a reduction of accessories, simpli-
ied base and porter bars, elimination of the engine control guard
late, and change of materials used in the pump.

This pump has an aluminum pilot gear cover and a stainless steel
haft, but is otherwise all bronze. Where difficulty due to either
orrosion or electrolytic action can be expected, the bronze unit is to be
referred.

Standard accessories include:

pressure gage, 0–400 p. s. i.	1 packing gland wrench.
starter ropes.	1 pair pliers, 6-inch combination.
grease gun.	1 screw driver, 4-inch.
spark plug wrench.	2 instruction books.
set, magneto and breaker point adjusting tool and spacer gage.	1 extra set of spark plugs.

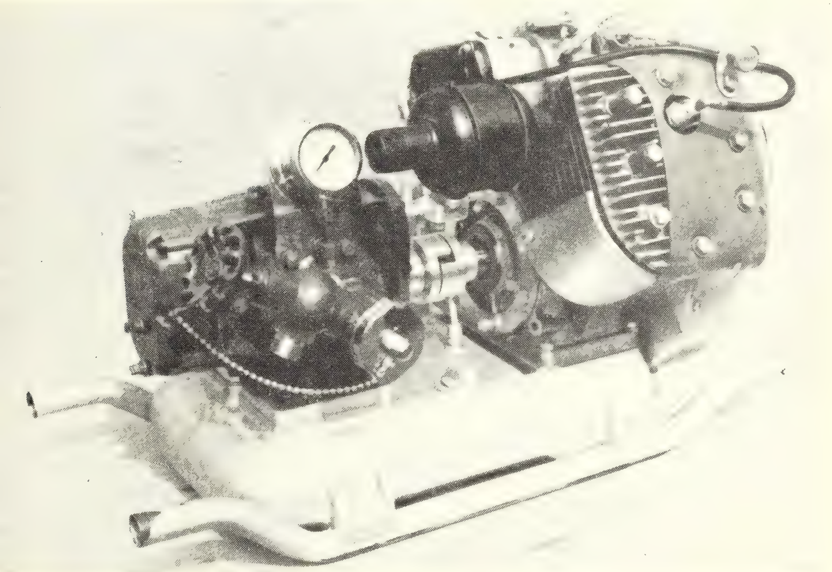

FIGURE 2.—Unit 2: Lower Cost U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance of this pumper compared with the specifications, re-
ised July 7, 1949, as follows:

Specifications:	*Test results*
Maximum weight: 130 pounds	100 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: 20 inches Hg. minimum	20 inches Hg.
Vacuum after 100 hours: 15 inches Hg. minimum.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. minimum.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i.	16.6 g. p. m.

Cost of the pumper, complete with standard accessories as listed, as of August, 1949, is $365 f. o. b. San Francisco.

It appears, after extensive investigation of possible applications of low-pressure fog and wet water, that a pump in this capacity range is to be recommended as being better suited for general service than units having lower discharge rates at lower discharge pressures. Details of the results of these studies are expected for release in an early issue of FIRE CONTROL NOTES.

UNIT 3

This unit consists of a pump, engine with accessories, base and carrying handles (fig. 3). It has a dry weight of 190 pounds, and its dimensions are 29 inches long, 22 inches wide, and 21 inches high.

Performance ratings are as follows:

Discharge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	45
100	40
250	30
310	25

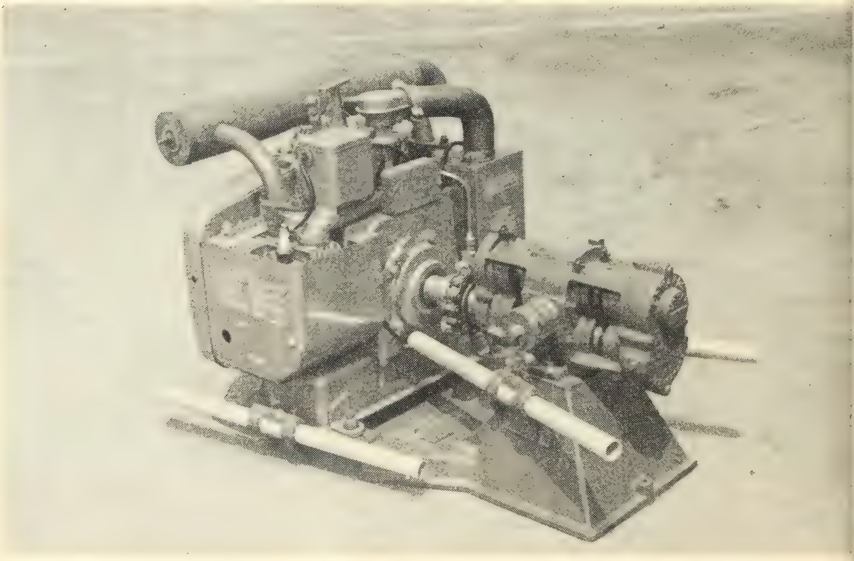

FIGURE 3.—Unit 3: U. S. F. S. Region 5 Model 49 Portable Pumper.

The engine is an air-cooled, opposed twin cylinder, 4-stroke cycle, L-head gasoline type, rated at 10 hp. at 2,700 r. p. m. and is equipped with a 12-volt electric starter-generator system provided for rope starting in an emergency. Commercial grade fuel, approximately 70 octane, is used, and is supplied from an auxiliary 5-gallon tank and fed to the carburetor by a fuel pump. Fuel consumption is approximately 1 gallon per hour when operating at normal rated load.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 2 quarts.

The pump is a positive displacement gear type, rated 30 g. p. m. at 250 p. s. i., at 2,600 r. p. m., and is equipped with chevron packing held in place by gland nuts which need be hand tightened only. Pump bearings and pilot gears are packed with grease and require service once annually. Connection of the pump to the engine is direct through a flexible coupling.

Standard accessories include:

- Adjustable carrying handles.
- 1 pressure gage, 0–500 p. s. i.
- 1 starter rope.
- 1 extra set spark plugs.
- 1 spark plug wrench.
- 1 packing gland wrench.
- 1 pair pliers, 6-inch combination.
- 1 screw driver, 4-inch.
- 1 set, magneto and breaker point adjusting tool and space gage.
- 1 crescent type wrench, 10-inch.
- 1 canvas tool kit.
- 1 can grease, 1-pound, suitable for packing gland and bearing.

Performance of portable pumper, U. S. F. S. R–5 Model 49, compared with specifications, revised March 23, 1948, as follows:

Specifications:	*Test results*
Maximum weight: 200 pounds	190 pounds
Maximum dimensions: 34 by 24 by 22 inches	29 by 22 by 21 inches
Vacuum when new: 20 inches Hg. minimum	22.5 inches Hg.
Vacuum after 100 hours; 15 inches Hg. minimum	16 inches Hg.
Normal output: 30 g. p. m. minimum at 250 p. s. i	31.5 g. p. m.
Maximum output when new: not less than 25 g. p. m. at 310 p. s. i	25.35 g. p. m.
Maximum output after 100 hours: not less than 23 g. p. m. at 300 p. s. i	23.03 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. Arcadia, Calif., was approximately $585 as of April 1949.

This unit is more suited for the large tanker or slip-on installations, or for areas where higher pump capacity is essential to effective control. While the electric start feature is a decided advantage, it should be recognized that a 12-volt system is required, thereby adding approximately 115 pounds extra weight. If desired the pumper is available without electric start at $480, as of April 1949.

Specifications covering these pumper units as well as details regarding tests and performance are available at Arcadia Fire Control Equipment Development Center, 701 North Santa Anita, Arcadia, Calif.

Woods Burner's Waterloo.—The following filler, taken from a recent issue of Bois et Resineux, explains what must have been a very effective forest fire control program in Napoleonic France.

In 1808 Napoleon I wrote one of his prefects the following letter:

Monsieur le Prefet, It has come to my attention that numerous forest fires have broken out in the section I have entrusted to your administration.

You are hereby ordered to have anyone guilty of starting fires shot at the scene of the fire. Furthermore, if fires continue, I will make arrangements to have you replaced.

Napoleon.

—Reprinted from Naval Stores Review.

USE OF PORTABLE FIRE PUMPER DURING SEPTEMBER 1932

PAUL H. RUSSELL

Assistant Supervisor, Nantahala National Forest

[The following article, written by P. H. Russell 17 years ago, has been included in this issue because it may be of interest to fire control men concerned with the development and use of portable pumps.—Ed.]

During the latter part of August 1932 a small fire occurred in the Cedar Run section of Summerhill Township, Cambria County, Pa., and was thought to have been completely extinguished. On September 8, this fire broke out and burned over a large part of an old dried out swamp. The fire was brought under control during the evening of the first day. Beaver Run ran along the west side and Cedar Run ran diagonally through the burned area. It was decided that on the following morning a portable fire pumper, which was lying in storage, should be rigged up and used. A crew, composed of four reliable men, was organized to operate the pumper and arrangements made for the use of a truck to transport the equipment. On the morning of September 9, the pumper started working on the Cedar Run fire. After 3 days on the Cedar Run fire, the pump was moved wherever it could be used. From September 9 until September 23 it was used every day except one and saw service on five fires.

Actual running time on the five fires was as follows:

Fire:	*Running time (hours)*	*Area burned (acres)*
Cedar Run	91	60
Summerhill	12½	6
No. 6 Schoolhouse	10½	5
Summit Country Club	1	½
Ebensburg	13	40

Thus, during the 2-week period, the pump worked a total of 128 hours, consuming 134 gallons of gasoline and 52 quarts of oil, and throwing approximately 15,000 barrels of water.

On an average the pump consumed 1.048 gallons of gasoline and 0.406 quart of oil per hour. With the total cost of the crew and transportation at $399.77, the gas and oil at $69.44, and a depreciation of $2 per running hour, the average cost per running hour would be as follows:

	Cost per running hour (dollars)
Crew and transportation	3.12
Gas and oil	.54
Depreciation	2.00
Total	5.66

The extremely dry period of September, with the conditions such that it was very difficult to completely extinguish fires, provided an excellent opportunity to try out the pumper. Several interesting observations were made.

On each of the first several days the pump was used, there could be noticed a considerable increase in the efficiency of the operating crew. This was due to the increasing familiarity with working details of the pump and hose and the use of water to the best advantage.

It was also shown in convincing manner, especially on the Cedar Run fire, that the pumper will not serve as a substitute for a well-constructed line. There were six breakouts on the Cedar Run fire that burned more than one-tenth of an acre. Only two of these breakouts were controlled by the pump without putting in a good line. One breakout was controlled by use of the pump before the middle of September when the fire still burned very slowly. The other breakout was controlled by the pump after the middle of September when fires burned as fast as a spring fire, and then only because the pump happened to be placed in an advantageous position and hose already partly strung out so that the breakout was fought before it had reached a size of more than one-fourth of an acre. The conclusion is that, unless the pump is already advantageously placed and plenty of hose immediately available, it is almost impossible to stop a fast running fire with the pump alone. This is due to the fact that the pump and a long stretch of hose cannot be moved fast enough.

On the Paddy Meadow fire, all but two breakouts occurred after the edge of the fire in to a distance of 40 feet had been completely wetted down for hours at a time. In one instance, the pump forced water on a small breakout for more than 3 hours on three separate occasions and yet, a day later, the largest breakout of the fire started from this same area. On the basis of a cost of $5.66 per hour to run the pump, this would be the equivalent of about 16 man-hours. There is a question as to whether in many situations the pump will do more than its equivalent in manpower, but under ordinary conditions it is undoubtedly more efficient in mopping up and is fairly convenient.

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PROGRESS ON PROPOSED FOREST SERVICE STANDARD SLIP-ON TANKERS FOR ¾- AND 1-TON VEHICLES

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER
Region 5, U. S. Forest Service

One of the Service-wide development projects assigned to the Arcadia Fire Control Equipment Development Center was the design and construction of a medium-weight slip-on tanker to fit pickup and express bodies of ¾- and 1-ton trucks, and which would meet the varying needs of all Forest Service regions.

In order to incorporate the most desirable features, suggestions and requirements were solicited from field men and many existing units were inspected in several regions. Information thus secured clearly indicated that the objective was the construction of a versatile unit, with the component parts so designed and mounted that alternate positions for pump, reel, and tool box and a reasonably wide selection of pumpers were possible. Furthermore, water capacities should be provided consistent with proper loading of either the ¾- or 1-ton vehicles and for either mountain or flatwoods operation.

The first unit designed and reported upon herein is for mountainous areas (fig. 1). A skid frame cradles the 125-gallon water tank and a watertight equipment compartment which can be used as a container for an additional 75 gallons of water when a 1-ton vehicle provides transportation.

The slip-on tanker is secured to the vehicle by means of four chains attached to the top of the frame. At the ends of the chains are hooks which engage eye bolts mounted in the bed of the vehicle.

On the top of the skid frame a rectangular base, supporting the reel and pumper, is attached by means of four bolts. This allows for reversing position of reel and pumper. And since, in plan view, the unit is square the user has a choice of eight different arrangements of reel, pumper, and tool box location when installing the unit in a vehicle.

The dry unit with pumper and reel, but without tools and equipment, weighs 623 pounds. The loaded unit, with tools and equipment as listed further in this article, weighs 1,910 pounds.

Water tank.—The water tank is 47 inches long, 30 inches wide, and 20 inches high, constructed of 14-gage black iron, and divided into four compartments by baffle plates. The entire top is removable to facilitate cleaning. The interior of the tank is treated with a sanitary rust preventive compound. Two sets of tank outlets are provided on the lid to allow for reversing positions of pumper and reel. These serve for fill spout, outlet for suction line from tank, tank vent, and relief valve discharge to the tank.

Equipment compartment.—Mounted alongside the water tank is a watertight box 47 inches long, 16¾ inches wide, and 21½ inches high, which serves as a tool box or as an auxiliary water tank (fig. 2).

For the purpose of safety, cutting tools are mounted on underside of the lid. Long-handled tools and suction hose may be mounted as desired, either on the unit or on the vehicle.

When a ¾- or 1-ton vehicle carrying the slip-on is operating on level highway, or at slow speeds on the fire, the tools and equipment can be removed from the equipment box, which can then be used for carrying an additional 75 gallons of water. Water is drawn from this compartment by means of the overboard suction hose. Revisions in the tank which will permit cheaper construction and eliminate the necessity for using the suction hose to draft from equipment box are planned.

Pump and reel frame.—The pump and reel frame is 50¾ inches long and 21 inches wide. Sufficient space is provided on the frame for mounting a hose reel 23 inches long and 21 inches in diameter. The space and installation facilities for the pumper permit the use of several different makes and models of portable pumpers now manufactured.

Pumper.—The pumper unit, which was installed on the pilot model, and illustrated in figure 1, has a rated capacity of 18 gallons per minute at a pressure of 250 pounds per square inch. It is of the positive displacement gear type and weighs 96 pounds. The engine is an air-cooled 4-stroke cycle gasoline type, rated at 6 horsepower at 2,700 revolutions per minute and is equipped for rope starting only.

Reel.—The high-pressure live hose reel will carry 250 feet of 1-inch cotton-jacketed rubber-lined, or ¾-inch high-pressure rubber-covered

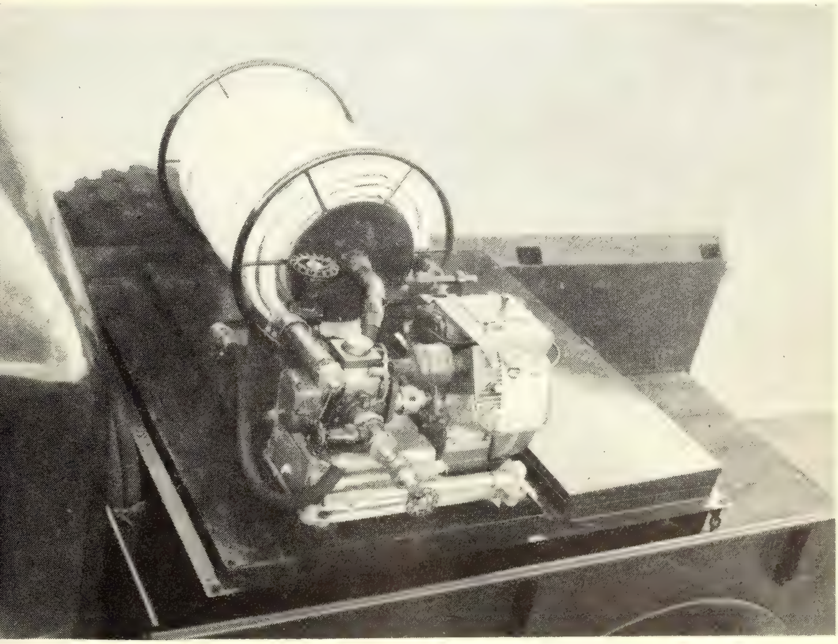


FIGURE 1.—Mountain type slip-on tanker for ¾- to 1-ton vehicles.

hose. The reel is equipped with a quick-throw friction drag brake and a geared crank for winding in the hose.

An alternate reel arrangement, consisting of either one smaller reel or two reels in the same space and equipped for small-diameter hose ($7/16$-inch or $1/2$-inch), is being considered.

Equipment.—One typical list of equipment is as follows:

250 feet—1-inch CJRL hose on reel
250 feet—1-inch CJRL hose
200 feet—1½-inch CJRL hose
20 feet—1-inch suction hose
1—5-quart gasoline tank (full)
2—shovels, No. 0
1—ax
1—brush hook
1—Pulaski
1—McLeod tool

FIGURE 2.—Tools and hose arranged in box.

Since tools and equipment vary somewhat according to the user's choice, no specific brackets or tool racks are included on the proposed standard unit, but would be obtainable as accessories.

Radio installations.—When the slip-on tanker is to mounted in the vehicle with tool compartment to the rear and reel and pumper in line across the bed, suitable space is provided across the back of the cab and above the tank for a mobile radio installation having remote controls in the cab.

Cost.—Estimated cost of the slip-on tanker, equipped with Region 5 Specification Model 48 Pumper but without accessories, is approximately $800. Information received from one manufacturer would indicate an eventual cost of about $650, if produced in quantity.

Thirteen units have been constructed and a few are now in experimental use in the field. Reports and comments on the unit to date have been very favorable.

Future work.—Following the completion of the mountain and flatwoods models a detailed report with photographs fully illustrating the versatility of the units will be made available to Forest Service regions and to State, private, and other Federal forest protection agencies for review and comment. Such reasonable changes as are essential to meet the needs of the interested agencies will then be made and the final proposal submitted as standard items of equipment for the Forest Service. If the resulting unit is satisfactory for adoption as standard by other agencies a reduction in the cost per unit can be expected.

Spiral Rotor Trencher—Preliminary Performance Report.—The January 1949 issue of Fire Control Notes describes the spiral rotor trencher designed and constructed in Region 6. Two of these units are being tested for performance on the Sierra and Trinity National Forests of Region 5, under procedures outlined by the Arcadia Fire Control Equipment Development Center. The purpose of the test is to determine the varying types of terrain, cover, and soils in which the machine can be operated as well as to bring out any weak spots in the mechanical construction of the equipment. The following is a brief summary of observed results to date:

Timber type.—The rotor trencher produced an excellent fire line in all types of duff encountered, whether composed of needles from pine or fir, or leaves from hardwood species. A fire line 18 inches wide was cut to mineral soil. A 6-inch berm on each side, composed of duff and dirt, added to the effective width. The trencher is able to push limbs, poles, and rotten logs aside so that very little advance clearing is necessary. Single-pass fire line is built at the rate of approximately 1 mile per hour.

Open-grass type.—Grass type, as a rule, proved the most difficult, because of the hard baked soil underneath. In one area a fire line 18 inches wide was constructed in which the grass was stripped off and very little dirt was moved. In contrast to this, where the soil was less firm, a 20-inch line in mineral soil was built, plus an 8-inch berm on each side, composed of grass covered with dirt, giving a 36-inch effective fire line.

Operating up a 20-percent slope, fire line was constructed at a rate of 0.92 mile per hour. Down the same slope, line was built at the rate of 1.24 miles per hour.

Bear clover.—The rotor trencher had no difficulty building a 19-inch line in bear clover, at a rate of three-quarters of a mile per hour. It could climb and build fire line up to a 50-percent grade in this type cover.

Mixed chaparral.—The rotor trencher was not designed to cut brush, but it was found a useful tool in this type, to build fire line around and underneath the brush by "worming" its way around obstacles. With a minimum of clearing in advance a good job can be done on "cold-trailing" in brush types.

Chamise type.—The rotor trencher is capable of building fire line in this type, since the stems are brittle and root systems are not too substantial. However, going is rough on both the machine and the operator.

Terrain.—Rocks up to 5 inches in diameter are readily handled by the trencher if they are in loose soil. Rocks imbedded in hard soil cannot be moved and should be avoided when possible. However, the machine is able to slide around the obstacles without too much abuse to the machine.

Fire line was built on side slopes up to 45 percent without difficulty when the surface was smooth.

The spiral rotor trencher shows promise of general adaptability to line construction in most fuel types. As in all new designs mechanical failures have been encountered. Difficulties in carburation on side slope and slipping of belts in the steering mechanism are problems that will require revised design. The principle of the spiral rotor for line construction, however, has definitely been proved to have merit.

Conclusion of the tests is scheduled for approximately January 1, after which a complete report covering rates of construction, grades, and fuel types to which the machine is adaptable will be made.—ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER, *Region 5, U. S. Forest Service.*

SLIP-ON CONVOY LUBER AND FUEL UNIT

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

One of the 1948 Service-wide projects assigned the Arcadia Development Center was a slip-on convoy luber and fuel unit to service fire camp equipment and trucks on fire lines away from roads. Such a unit has been built and tested, and is reported briefly in the following:

The unit is designed to fit a ½- or ¾-ton pickup, but can be used in 4 x 4's or 1½- to 2-ton stakesides, as well as in the multi-purpose tractor-drawn trailer, described in the April and July 1948 issue of Fire Control Notes, Vol. 9, page 31.

The luber consists of a gas engine driven compressor and air storage tank, two pressure lubrication pots, and a tool box mounted on a skid frame (fig. 1).

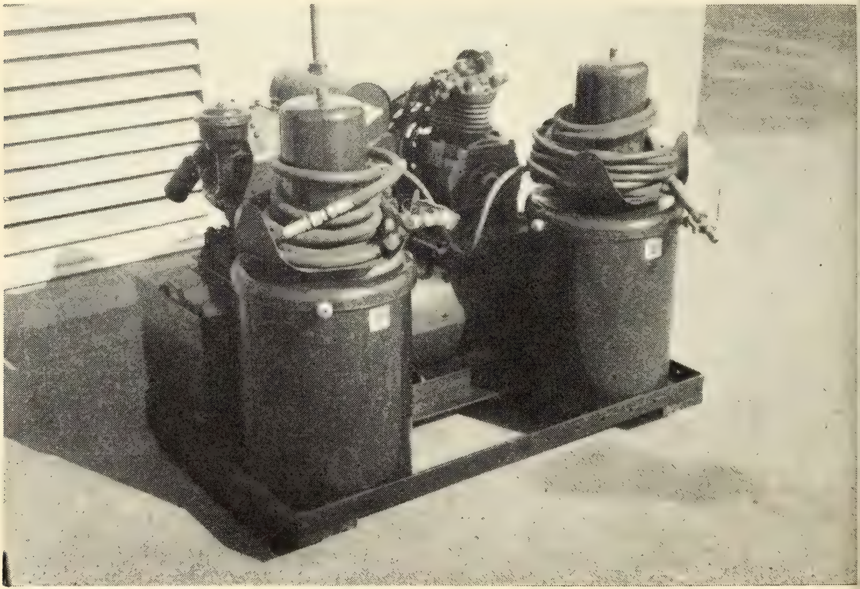


Figure 1.—Slip-on luber.

The over-all dimensions are 3 feet 9 inches long, 2 feet 5 inches wide, and 3 feet 1 inch high. The two-stage compressor is belt-driven by a 4-cycle gas engine. The air tank is 12 inches in diameter by 36 feet long, built for a maximum operating pressure of 175 pounds. A pressure regulator and 24 feet of ¼-inch high-pressure air hose are provided.

The two lubrication pots have 100 pounds grease capacity each. One is provided for E. P. 90 gear lube and the other All-Purpose chassis lube. Each pot has 20 feet of high-pressure lube hose and a grease gun.

The tool box is 6 inches wide, 14 inches high and 14 inches long, and holds the grease fittings, air fittings, and the necessary hand wrenches and tools.

Estimated cost of this unit is $575, f. o. b., Arcadia. Weight is 625 pounds.

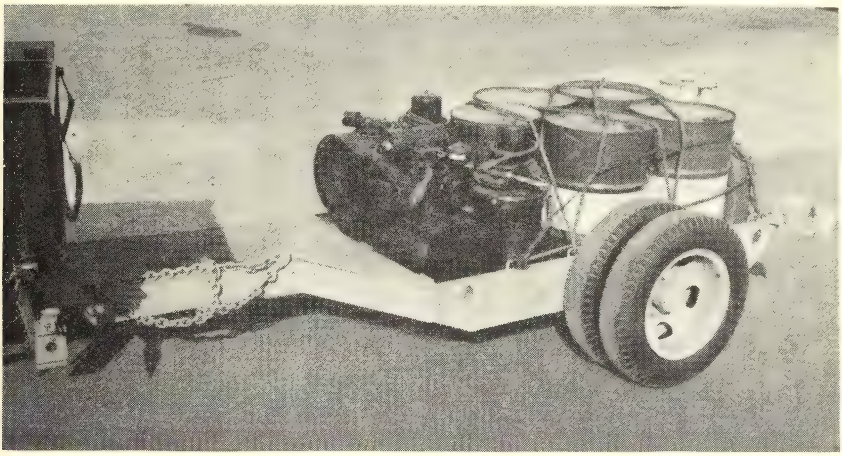


FIGURE 2.—Luber and fuel supply in utility trailer.

When this slip-on luber is used in the tractor-drawn trailer (fig. 2), four 55-gallon drums of Diesel fuel, one 30-gallon drum of water, one 15-gallon drum of motor oil, and two 5-gallon G. I. cans (one for cleaning solvent, the other for gasoline) can be carried.

The supplies noted are in about the right proportions, and have been used to service five D–7 or D–8 tractors for one 12-hour shift, or one D–7 or D–8 tractor for five 12-hour shifts.

The tool box on the trailer tongue will hold one oil measure can, one 5-ton jack, one taillight bracket, one clearance light bracket, one trailer hitch, 50 feet of ¾-inch manila tie rope, one barrel pump plus 10 feet of fuel hose, and some wiping rags.

The luber, plus the above load in the trailer, was designed to be pulled behind the tractor on its first trip into the working area. This saves the time of walking the tractor, or tractors, out to the road for servicing and back into the working area.

Plans and detailed construction drawings are available and may be obtained for all of the above described equipment from the Arcadia Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

[Since design of the luber there have been many versions of the convoy luber made available commercially. The Development Center will be glad to forward list of manufacturers and descriptive literature to any who may be interested.]

NEW PLASTIC TOWER PROTRACTOR

NEIL LEMAY

Chief Ranger, Forest Protection Division, Wisconsin Conservation Department

The Wisconsin Conservation Department is now starting its second year with the new plastic tower protractors, and to date the protractors have held their shape and accuracy and have stood up well under usage.

Prior to 1948 we used, with a few exceptions, paper protractors and maps mounted on Prestwood in our towers. We were constantly confronted with distortion due to mounting and with considerable replacement of the units. We tried to protect the mounted map and the protractor with glass covers, varnishing, etc., but still did not attain the desired results. As a consequence we searched for some other material for our protractor and for another method of providing the towerman a map that would not have to be replaced so frequently.

Investigation led to the selection of a plastic protractor 20 inches in diameter made of General Electric Textolite No. 2097 (fig. 1). The protractor was drawn to scale at our drafting office and was graduated in degrees and half-degrees with numbers every 10 degrees, running clockwise from zero to 360 degrees. From this the fabricating company prepared a plate and printed it on the face sheet of plastic, black on white. (This can be reversed if so desired.) This face sheet was then incorporated as a part of a laminated plastic structure to form a plastic sheet about 0.07 inch thick that is stable and practically indestructible. This was done at a cost of less than $2 per protractor in lots of 100. A 3/16-inch hole was drilled in the center of each protractor for fabrication purposes.

It was recommended by the fabricating company that these protractors be mounted on waterproof 7/8-inch plywood, using Cascamite or Weldwood with at least 50 pounds per square inch pressure, for the protractor unsupported has a tendency to warp though it does not change dimension. It was found that this mounting was easily accomplished with our shop hydraulic press, and as a matter of fact we used about double the required pressure and bonded as many as 30 protractors and bases at one time. We have had no failure in the cementing up to the present time, and it appears likely that none will occur.

To eliminate wear on the face of the protractor, plain black 10-inch diameter disks of Textolite (grade 10700 with black filler) were secured. They were placed on the protractor and served as a base for the alidade to ride on, keeping it just clear of the numbered edge of the protractor. The disks can be successfully cemented to the face of the protractor with Cascamite if desired.

The protractors were then carefully oriented in the towers by using azimuths from triangulation control data and securely fastened to the tower cabinet.

This arrangement prevented us from mounting a map with the protractor as we had done before, and so we are trying out the following map scheme. In place of the maps of ½-inch-per-mile scale that we formerly used, we have substituted our quadrangle maps, scale $^8/_{10}$ inch per mile, similar to the ones used by our dispatchers. The new tower maps have 6-inch protractors overprinted in red ink and are mounted on quarter board. They are composed to give about 15 miles coverage in all directions from the tower. Eyelets are inserted on each tower position on the map, as in dispatching maps, and either strings and weights or celluloid arms are used to cross up the fires. The maps are framed, varnished, and mounted so as to hinge up to the tower ceiling or against the side so that the map is protected except when actually being used. It is our hope that this system will give more service than our previous one and will also give more accurate information to the towerman.

For further information, such as source of supply of plastic disk, write to Chief Ranger, Forest Protection Division, Wisconsin Conservation Department, Tomahawk, Wis.

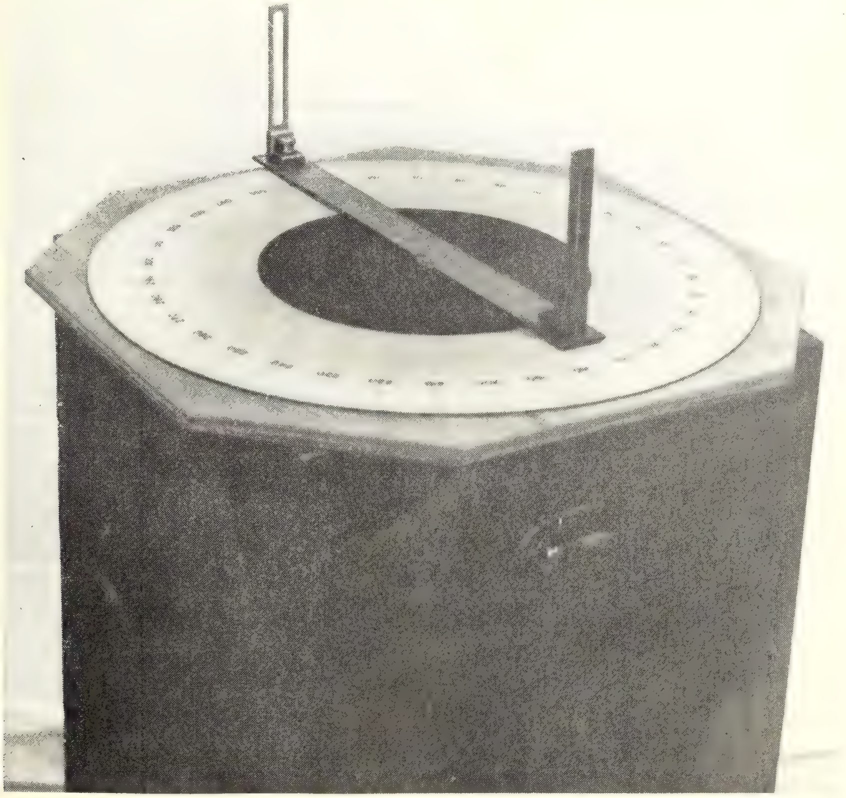


FIGURE 1.—Plastic protractor oriented and securely fastened to tower cabinet, showing riding position of alidade on Textolite disk. Protractor is 20 inches in diameter and is mounted on waterproof ⅞-inch plywood.

ARKANSAS FIRE FINDER

G. M. Conzet

Forester, Region 8, U. S. Forest Service

The Arkansas Division of Forestry and Parks is now equipping all of its towers with a new azimuth circle and alidade that are an improvement over the instruments currently used by many States. The project for developing this equipment was initiated and guided by Fire Control Chief R. M. Henry with the cooperation of Max Levine, instrument maker, and Carl Martin Manufacturing Co. of Little Rock, Ark. The equipment has been designed and built for simplicity and sturdiness as well as for ease and accuracy in operation.

The azimuth circle is 21 inches in diameter with 1-degree graduations and ½-inch figures stamped on aluminum plate $\frac{3}{16}$ inch in thickness and 24 inches in diameter. This makes a permanent rigid base and circle. In order to reduce glare to a minimum, the surface of this plate is coated with black wrinkled enamel sprayed on and baked. The stamped-in figures and degree marks are filled with phosphorescent paint to make them stand out better for both day and night reading.

The mounting of the aluminum plate and azimuth circle is by way of hinge-type guides attached to the under side. Opposite the guides are two leveling screws. The guides slide on a straight ¾-inch steel rod attached to a baseboard by brackets and bolts. The bolt holes for attaching the guides are slotted to provide for minor adjustments (as much as 5 degrees) when orientating the circle. There are 10 inches of lateral movement on the steel bar, which is sufficient to clear most tower cab obstructions in sighting. Opposite the slide bar and parallel to it is a flat iron bar bolted to the baseboard. This provides a true surface for the leveling screws. A center hub or pivot base with dowel, lock washer, and tension spring is attached to the center of the azimuth circle plate by four countersunk screws.

The main bar and sighting vanes of the alidade are of special high-strength, heat-treated aluminum riveted together permanently and finished with nonreflecting black paint.

All friction surfaces are of brass to prevent galling of those parts. The sighting vanes are 6 inches high and 18 inches apart. The bar and vanes are 1½ inches wide. The front vane has a vertical hair while the rear or near vane is slotted. This rear vane has a round opening close to the top and one near the bottom for coarser sighting or for use when light is poor. The rear end of the bar protrudes 2½ inches beyond the sighting vane, thus providing room for a circular opening 1¼ inches in diamter directly over the azimuth circle figures and through which the reading is made. To provide for accurate reading a black nylon index has been placed in this opening in direct line with the sighting parts of the vanes.

The azimuth plate is mounted with "O" azimuth to the south so that bearings may be read direct from the rear of the alidade.

Mr. Henry advises that manufacturers are now prepared to go into mass production. Prices from $15 to $37.50, depending on the number ordered, have been quoted. Inquiries for further information, including names of suppliers, should be addressed to R. M. Henry, Fire Control Chief, Arkansas Division of Forestry and Parks, Little Rock, Ark.

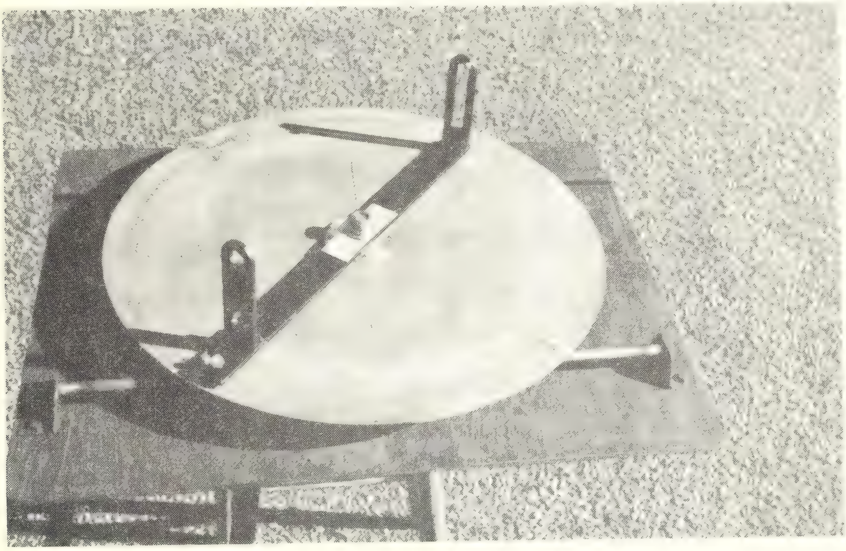


FIGURE 1.—Over-all view of the Arkansas fire finder before plate has been enameled and the figures and degree marks filled with phosphorescent paint.

IMPACT OF DESTRUCTIVE FOREST FIRES ON THE TIMBER RESOURCE OF A MANAGEMENT UNIT

C. A. Gustafson

Chief, Division of Fire Control, U. S. Forest Service

During 1945–47 a study of a management unit covering 1,689,400 acres of a major watershed was carried on to determine the total land area capable of supporting a stand of timber. A fire study was carried on simultaneously to determine the impact of destructive fires on the current timber producing capacity of the land, and to define that impact in economic terms.

An aerial photographic survey of the management unit provided the base for interpretation and determination of land capabilities. Sufficient field work was carried on to make sure that aerial photographs correctly interpreted can be used to classify land capabilities, particularly if those making the study are intimately familiar with the area. Other sources of material were fire reports, cut-over reports, cruise data, and management plans. Contacts with local people and others provided valuable information concerning fires that burned prior to 1905, at which time organized fire protection was begun, and immediately following 1905 when statistical fire data were not recorded in a completely satisfactory manner.

The land capability study of the management unit indicated that prior to the coming of the white man approximately 1,168,300 acres were covered with a stand of timber averaging about 20,000 board feet per acre (fig. 1). The total area of the unit was classified as follows:

Land capability:	*Acres*
Timber producing	1,168,300
Not suited to producing timber:	
Sagebrush and grass	39,000
Meadow	104,100
Lakes	3,000
Nonproducing [1]	375,000
Total	1,689,400

[1] Includes such areas as brush fields not capable of growing timber, land not suitable for agriculture nor supporting a stand of grass, rock outcrops, and barren land.

The fire study revealed that very few destructive fires occurred in the unit prior to the arrival of the white man. It is evident, however, that numerous lightning fires did occur although very few resulted in complete destruction of the timber stand. The total area on which the timber was destroyed by fire prior to 1905 was determined as slightly less than 50,000 acres.

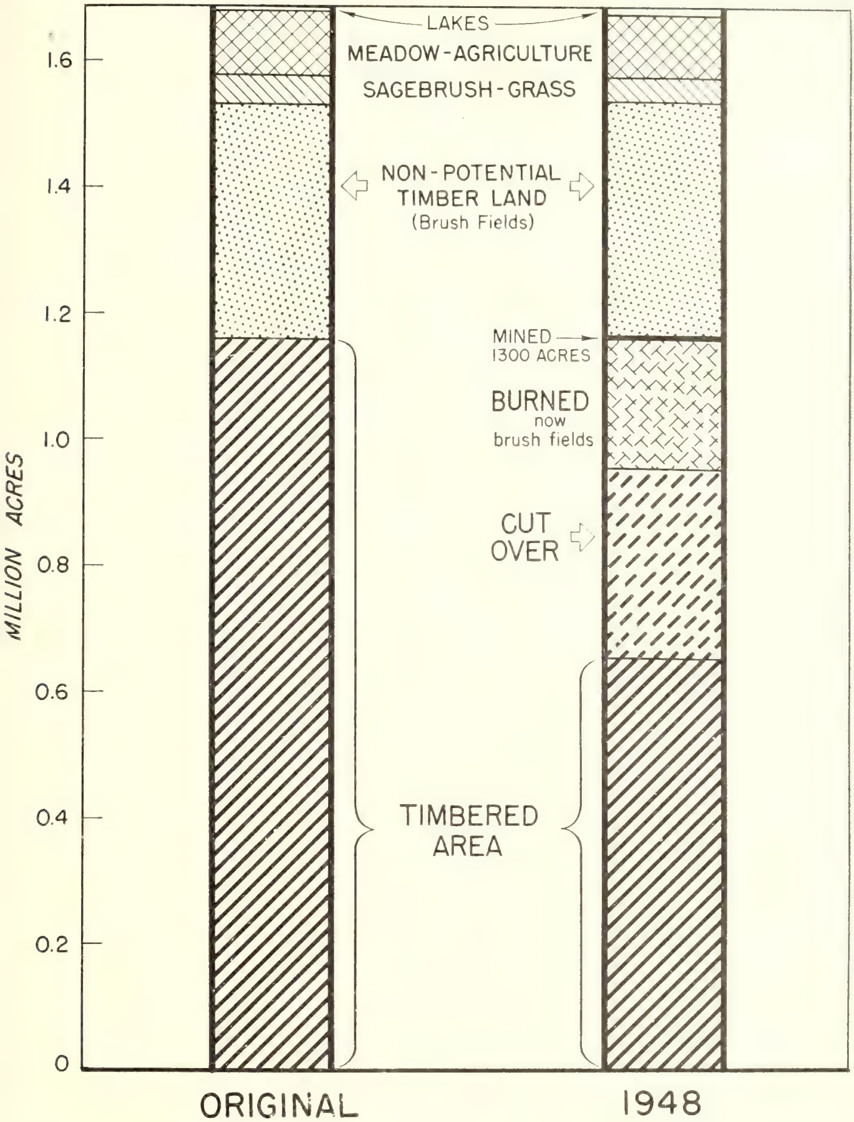


FIGURE 1.—Original timber resource situation as compared with that of 1948.

The aerial photographs were studied and the boundaries of destructive timberland fires were delineated on the map. These were confined to fires that crowned out, thus resulting in total kill of the timber stands.

Fire reports were studied to determine the year the original fire scars were made. After all available reports were considered, there remained a number of fire scars to which a date of origin could not be attached. Discussions with local people and others known to have worked in the area provided some helpful information. In this way

the year and area of the destructive forest fires occurring within the unit after 1905 were determined (table 1). All fires previous to 1905 were lumped together.

The date assigned each of the destructive fires that resulted in a nonreproducing brush field was the date of the fire resulting in total destruction of the timber stand. There may have been fires previous to this date that burned over the area, but that did not get into the crowns and completely kill the timber. Also, there may have been some reburns of brush fields, but these were not cataloged since they did not result in the destruction of the original stand of timber.

Table 1 shows that 4.16 percent of the timbered area of the management unit was destroyed by fire previous to 1905. It also shows that during the 44-year period 1905–48 the fire-control organization failed to reach the area burned objective (one-tenth of 1 percent), except during 1940–44 when the average annual burn was kept to 0.092 percent. The percent of timberland burned was obtained by dividing the area burned during the period by the total area of timberland remaining at the beginning of the period. As the total timbered area decreased, the allowable burn objective in acres became smaller. For example, in 1905 it was 1,117 acres, while in 1949 it would be 958 acres. This type of calculation was used in determining the effectiveness of fire-control measures in the protection of the unit. Figure 2 shows the relative success or failure in protection, failure being considerable in the period 1905–34, success being approached or reached during the period 1935–44. It also shows that since 1944 the fire organization is again operating on the failure side of the burned area objective line.

Table 1 and figure 2 show rather conclusively that successful forest management is not possible for this unit, with the degree of protection that has been provided.

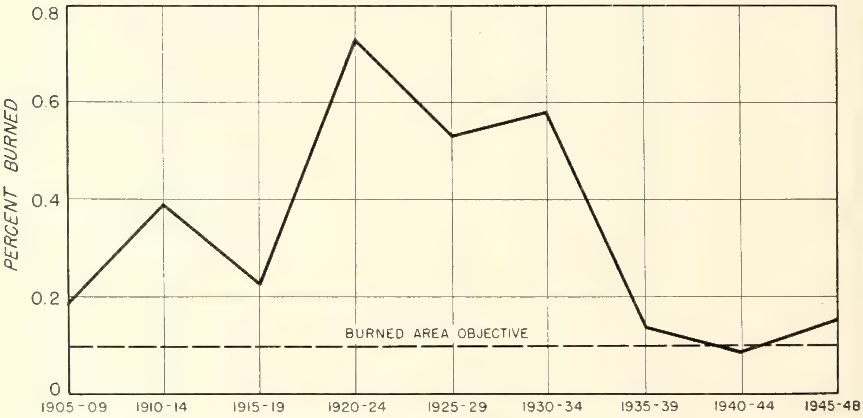


FIGURE 2.—Percent of timbered lands destroyed by fire, by periods, 1905–48.

A review of the condition of the management unit as of 1948 (fig. 1) showed that out of the original 1,168,300 acres of timbered lands, fire had brought about the formation of 209,000 acres of nontimber producing brush fields. The 209,000 acres on which the timber was destroyed is not a true measure of the total timberland burned over,

TABLE 1.—*Area of timber destroyed and percent of timbered area burned by destructive fires, by periods*

Period	Timber stands destroyed	Area remaining in timber at end of period	Timbered area burned	
			By period	Annual average
	Acres	*Acres*	*Percent*	*Percent*
Prior to 1905	49,000	1,117,800	4.16	
1905–09	10,600	1,107,200	.94	0.188
1910–14	21,500	1,085,700	1.94	.388
1915–19	12,400	1,073,300	1.14	.228
1920–24	39,300	1,034,000	3.66	.732
1925–29	27,700	1,006,300	2.68	.536
1930–34	29,200	977,100	2.90	.580
1935–39	7,100	970,000	.71	.142
1940–44	4,500	965,500	.46	.092
1945–48	7,500	958,000	.78	.195

because many of the large fires did not go into the crowns. The figure represents the area of crown fires that resulted in a total destruction of the timber stands. Loss of increment due to ground fires must have been quite high, but there was no way to determine this loss from the data readily available. Mining, primarily in the form of hydraulic diggings, took another 1,300 acres of timberland out of production. Hence by the end of 1948 there remained 958,000 acres of land currently producing a timber crop. The situation at the end of 1948 was as follows (fig. 1):

	Acres
Timbered area (including virgin and cut-over areas)	958,000
Potential timberlands (timber totally destroyed by fire, now brush fields)	209,000
Nonpotential timberlands:	
Mining diggings	1,300
Sage brush and grass areas	39,000
Meadow and agricultural land	98,000
Lakes	9,100
Brush fields, rock areas, etc	375,000
Total	1,689,400

A review was made of the 14 most destructive fires occurring in the 44-year period 1905–48. These 14 fires destroyed about 85,000 acres of timber, or approximately 53 percent of the total area destroyed since 1905. They were all extra-period fires, thereby emphasizing the need for early aggressive attack on all fires starting during periods of high fire danger and for employing the best skill possible in their control. The years in which the most destructive fires occurred were 1905, 1910, 1918, 1924, 1926, 1931, and 1934, with 1924 probably the worst, followed by 1926 and 1934.

Destructive fires on this management unit have resulted in the loss of 4 billion board feet of timber. This includes a calculated loss of increment, approximately 140 board feet per acre per year, due to taking the timberland out of production. It does not include the millions of board feet salvaged during the period. Slightly more than 3 billion feet of this loss occurred after the unit was placed under protection in 1905. Figure 3 shows the timber volume losses due to destructive fires.

The volume logged since 1905 totals 5.2 billion board feet (fig. 3), including the volume of burned timber that was salvaged. About

299,000 acres of the original timbered area of the unit has been cut over (fig. 1).

The original volume of timber on the unit is estimated at 22.4 billion board feet. Volume lost as a result of destructive fires is 4 billion board feet and the volume removed through logging totals 5.2 billion board feet. The estimated volume remaining on the unit at the end of 1948 is 13.2 billion board feet of which about 10 billion board feet is classed as commercial.

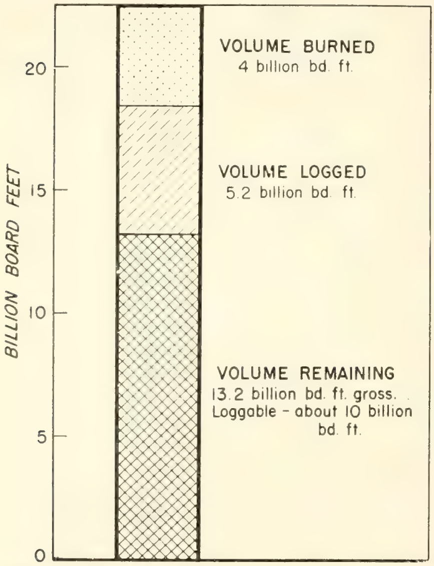


FIGURE 3.—Reduction in total original volume of timber due to fire and logging.

The figures on volume reduction reveal that 43 percent has been due to fires. In other words, the loss of timber by destructive fires has almost kept pace with the volume taken out through logging. Another way of emphasizing the severity of fires is to state that the potential pay roll lost because of fires is almost equal to the total woods and mill pay roll since 1905.

In order to determine the economic value of the total timber loss due to destructive fires, the average price per thousand board feet for timber sold by the management unit in 1948 was used. This figure, \$13.16, applied to the volume destroyed, reveals that the present value of timber lost due to previous destructive fires would amount to the staggering sum of \$52,640,000.

Most of the destructive timber fires in this area result in the creation of dense brush fields where it is almost impossible for regeneration of trees to take place. The destructive fires usually take the land out of timber production for a great many years, in some cases for more than 100 to 200 years. For that reason, the annual increment loss due to these fires may be directly chargeable to failures in fire protection. This loss is estimated at 29 million board feet annually. The current average stumpage rate of \$13.16 per thousand board feet applied to this volume indicates that the owners of the management unit are losing about \$381,640 each year because of past failures in fire protection.

This dollar value, which is charged as an annual increment loss, is 2½ times the \$150,000 now being spent annually by the owners to protect the unit. The protection price being met by the owners, however, is not the \$150,000 actually being spent, but more than \$500,000, which includes the monetary value of the annual increment loss due to past failures in protection. Looking at it another way, if successful protection had been accomplished through the years, the value of the annual increment now lost would more than pay the present annual protection bill.

The total loss in loggable timber, calculated at a value of $52,640,000, cannot be overlooked. If the owners had spent such a sum on fire protection and the protection had been successful, they would have at least broken even. It appears defensible, therefore, to say that more than $1,000,000 could have been spent annually for protection on the area. It is certain that this amount is many times the amount that would be needed to provide the degree of fire protection required to assure successful management of the timber resource.

It can be concluded that the failure in protecting this management unit from destructive forest fires has resulted in a real monetary loss to the owners. If they had annually invested a small amount of additional funds in protection, they would have approximately 160,000 acres of timber producing lands that they do not now have. In their present condition these lands will not produce any real timber values for more than a hundred years, unless artificial revegetation (somewhat doubtful in such brush fields) can be accomplished. In addition, the loss of the vast amount of raw material has meant a potential payroll loss of more than $100,000,000, a matter for real concern.

Intangible losses, never measurable, would undoubtedly raise the total loss chargeable to destructive forest fires much higher than that calculated here, probably to somewhere in the neighborhood of $200,000,000.

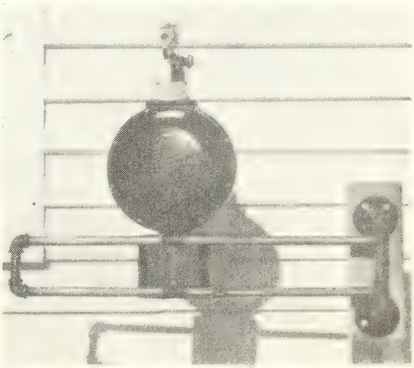
An analysis of losses due to destructive fires in relation to the amounts spent for fire protection might well be made for other timber management areas throughout the Nation. These analyses could provide forceable arguments for more adequate fire protection.

Navy Deck Alidade as a Forest Fire Finder.—The Connecticut Park and Forest Commission has installed in some of its towers a new forest fire finder, which may be of interest to others if the instrument becomes available in quantity at a reasonable price. The Commission purchased 20 of these instruments (Model O, Mark V) from the University of Connecticut's education department for 50 cents each. They were surplus property presumably acquired for training purposes.

This instrument, used by the United States Navy, is called surface lookout alidade or Navy deck alidade. It is a simple device with an azimuth circle that can be read easily and rapidly.

The high-powered finder was replaced by a ½-inch brass sighting tube about a foot long, with cross hair in it. Binoculars can be fastened on the sighting device if desired.

The State has not tested this instrument thoroughly, but several towers will be equipped with them for the 1950 spring fire season. Three have already been installed. One advantage of this finder over the ordinary alidade is it allows more room for the observer, and any visitors, in a 7- by 7-foot cab. It is also possible its use may increase accuracy. A disadvantage may be that it cannot to moved to avoid sighting into the four corner posts of the cab.—Ed Ritter, *Forester, Region 7, U. S. Forest Service.*



Navy deck alidade, with brass sighting tube. Azimuth is read at white strip.

STREAM FLOW AS A MEANS OF FORECASTING PERIODS OF EXTREME BURNING CONDITIONS

Mason B. Bruce

Forester, U. S. Forest Service, Washington, D. C.[1]

The White Mountain National Forest, like most of the New England State fire-fighting services, was caught napping during the fall of 1947. Standard fire-danger meters indicated the usual fall build-up of burning conditions which takes place as soon as fall frosts clear the trees of leaves. Although it was realized that general conditions were much drier than usual, no one on the forest foresaw the likelihood of such a catastrophic fire as the Fryeburg-Brownfield fire which made its major run just a few miles from the national forest boundary.

In an attempt to profit by experience, forest personnel spent considerable effort trying to find out how the extreme burning conditions might have been foreseen in time to alert local fire-fighting organizations and establish commensurate prevention and suppression safeguards. Graphs showing day-by-day fire danger as measured by 5–B and 5–W forest-fire-danger meters failed to give any indication of a build-up during the summer months of 1947. Charts showing occurrence of precipitation by days or periods likewise failed to show a trend sufficiently different from ordinary to be a basis for alarm. None of the accepted indicators seemed to give cause for apprehension.[2]

It was recalled that during the summer of 1947 local farmers complained that wells which had produced abundantly for long periods had gone dry during August and September, and the peak water shortage had occurred just about the time the huge fires reached their climax in October. Perhaps there might be a relationship between the sustained occurrence of unusually low ground-water levels and extreme burning conditions.

Unfortunately, the U. S. Geological Survey maintained no ground-water measuring stations in the vicinity of the National Forest. The nearest thing to an indicator of ground-water fluctuations seemed to be departures from normal in stream flow, there being a rather close

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[1] Formerly Assistant Supervisor, White Mountain National Forest.

[2] Forest Fire Danger Meters 5–B and 5–W were developed at the Southeastern Forest Experiment Station. Personnel at the station have believed for some time that the meters probably do not indicate as high danger as exists during prolonged periods of dry weather. They have consequently been doing some work with the idea of incorporating a drought factor. Progress to date has not been sufficient to know the value of its inclusion.

Use of the 5–W 100 meter was not begun in Region 7 until the fall of 1947. Consequently, White Mountain National Forest's experience with it in the month of October of that year was extremely limited. Since that time burning indexes for each day in October for the years 1943 to 1947, inclusive, were summed for New Hampshire. By October 21 the cumulated burning index for 1947 was 313 as against 159 in 1945, the next highest year. This would indicate a sharp build-up for that month in 1947.

Under similar conditions of drought, intermittent rains of small amounts should perhaps be ignored and the wind velocity carefully watched. Wind velocity is by far the major factor in fire danger, and an increase during a drought period is indicative of extreme danger.

relationship between stream flow and the supply of available ground water. The Geological Survey advised that it could furnish monthly discharge data for the year 1947 as well as monthly normals for one of the important streams leaving the forest. Current data for the same stream could be made available on the second day of each month for the preceding month.

Using the data provided, plus and minus departures in stream flow from monthly normals were plotted to a convenient scale. It was found that during 1947 a gradually increasing deficiency in stream flow became apparent in early July, reaching a peak in late October. The minor storms which occurred during late summer had little effect on the trend which showed strikingly on the graph. Here was a measurable trend that originated several months before the extreme burning period. It seemed that the method might furnish a practical, if empirical, means of forecasting conditions that lead to explosive forest-fire situations.

Further checking was needed to determine if similar sustained stream-flow deficiency trends may have occurred at other times in the past and, if so, whether these outstanding deficiencies were accompanied by bad forest-fire situations. Stream-flow data for the preceding 10 years were obtained from the U. S. Geological Survey, and departures from normal flows plotted in the same manner. During the decade prior to 1947 there occurred only one period, the spring of 1941, when stream-flow deficiencies comparable to late summer and fall of 1947 occurred. It was during this same spring of 1941 that the disastrous Stoddard-Marlow fire of some 25,000 acres occurred in west-central New Hampshire. Burning conditions were known to be extreme at that time and control was obtained with a change in weather. The other less extreme but relatively severe fire periods which had occurred in New Hampshire during the years studied tied in closely with measurable but less striking trends in stream-flow deficiency.

This coordination of events tended to confirm the original findings. The graph in a somewhat similar form has been kept current since 1947 as a means of forecasting the possibility of unusually extreme forest-fire situations. In no way does it replace the standard fire-danger meter for current fire-weather conditions.

WET WATER FOR PRETREATING LITTER FUELS

Wallace L. Fons and Robert S. McBride

California Forest and Range Experiment Station

Forest fire fighters often use water to wet the unburned material bordering the fire line or to sprinkle the area adjacent to a backfire line as a safety measure to reduce spot fires and flaring across the line. The question has been raised as to how the application of wet water would influence the length of time this precautionary measure is effective.

To answer this question an experiment was conducted at Pilgrim Creek on the Shasta National Forest. Two types of forest fuels were studied: ponderosa and lodgepole pine needles, and ponderosa pine twigs ¼-inch in diameter and 4 inches long, with bark intact. The material (four samples of each) was loosely packed in wire screen baskets, 1 foot square and 2 inches deep. The samples were weighed and set out at 8:30 a. m. on a bed of pine needles fully exposed to sun and wind. At noon they were again weighed, and two samples of each fuel type were treated with water and two of each with wet water. The liquids were applied in the form of a fine spray until the samples were saturated.

After the wetting treatment, the samples were weighed periodically throughout the afternoon to determine the moisture losses by evaporation. To represent conditions of a typical fire day, a hot dry day was purposely selected for the study. Average temperature during the afternoon was 90° F., average humidity 17 percent, and wind velocity 4 miles per hour.

For ponderosa and lodgepole needles the evaporation loss during the first 20 minutes was greater with wet water than with plain water. After 20 minutes, however, there was a reversal and the greatest loss occurred from needles treated with plain water. This occurs because at first the wet water spreads over a greater area on the needles and thus exposes a large surface to evaporation. Conversely, the plain water does not spread readily but remains in droplet form, so that a smaller total area is exposed to evaporation. After a short period, however, the excess wet water evaporates; the remainder, which penetrates into the needles, is held tenaciously, reducing the rate of evaporation. Plain water does not readily penetrate the needles but remains on the surface and is evaporated.

For the twigs, though, this 20-minute reversal is not apparent. Twigs treated with wet water retained the most moisture in the first weighing. It is probable that both plain and wet water penetrate the porous bark of the twigs and evaporation is not solely a surface phenomenon. The wet water penetrates deeper and becomes more inaccessible to evaporation.

How may this information be applied to problems in the field? What does it mean to a man setting a backfire? Sixty minutes after spraying with wet water ponderosa pine needles had a 17.5 percent moisture content; those moistened with water alone had 12.5 percent. Let us assume a hypothetical case with wind of 10 m. p. h., slope of 30 percent, and temperature of 81°–90° F. Under these conditions the Region 5 fire danger indexes for moisture contents of 17.5 and 12.5 percent are 25 and 16. Therefore, we can say that the application of wet water instead of plain water, after 60 minutes, gives an advantage of 1½ in reducing the spread of fire.

Another way to look at the situation is this: We might suppose that a fire boss wants to backfire an area. He wets the adjacent material. However, he does not burn it immediately because of some unforeseen problem. How long will the wetting be effective, supposing that 12.5 percent is the critical moisture content? Water allows him 60 minutes to do the burning; with wet water he has 95 minutes before the moisture content reaches 12.5 percent. The use of wet water would give him an advantage of half an hour.

Aircraft Use, 1949.—Aircraft during 1949, in connection with fire operations by the U. S. Forest Service, made 7,957 flights for a total of 10,548 hours of flying. They transported 8,770 men and 1,318,000 pounds of cargo.

Tractor Dozer Use, 1949.—During 1949 tractor dozers were used on 287 fires fought by the U. S. Forest Service. Work accomplished involved construction of 22,339 chains of held fire line, 10,942 chains of safety and lost line, and 14,363 chains of "ways" prepared for the ingress and egress of transportation equipment, a total of 47,644 chains, or 895 miles, of fire line and "ways."

Tanker Use, 1949.—The U. S. Forest Service reports that out of a total of approximately 11,000 fires occurring on national-forest protection areas during 1949, tank trucks were used on 2,382 fires or about 22 percent of the total. They were used as the primary means of initial attack on 1,281 fires and of this number assured control of 1,001.

TESTS SHOW CIGAR AND CIGARETTE STUBS COME DOWN HOT

H. T. GISBORNE [1]

Ever since airplanes began flying over the forests there have been lively discussions as to whether or not burning smoking materials thrown from an airplane might start fires. Recently, Mr. C. M. Johnson, assistant director of Keep Washington Green, Inc., asked us the direct question: "Can lighted material (meaning smokes) thrown from a plane ignite forest materials?"

We had some facts, based on tests that Bevier Show and I made back in 1922, plus at least 100 trials I have made since then. Those tests showed that all sources of heat as large and as hot as the coal that breaks off a hand-rolled cigarette would ignite dry, rotten wood.

We also had enough cases to justify the opinion that on loose duff or crushed-down dead grass, a hot pipe heel was most dangerous, a hand-rolled cigarette second, and a "tailor-made" third. No tests with cigars were made.

The reason for the above order of danger lies in the fact that a pipe heel or coal from a hand-rolled, which usually breaks off, is likely to filter down into the duff or grass where it touches more pieces of fuel and where more of its rising heat is effective in warming material above it. The "tailor-made," by contrast, more frequently comes to rest on top the duff or grass, touching only two or three pieces of fuel. Most of its heat therefore rises up into the air where it dissipates quickly.

Even with oven-dry duff and grass, Show and I got very few ignitions from any source unless we turned a fan directly on the spot. And that, by the way, was the method used by the Bureau of Standards in their tests some 20 years ago. However, as the wind velocity at the grass roots or the duff surface under a tree or brush canopy is seldom more than 2 or 3 miles per hour, we did not assume that much wind should be considered as normal. Under abnormal conditions almost anything can happen, of course.[2]

Hence, we had some basis for an opinion on the relative dangers of pipe heels and cigarette stubs on rotten wood, duff, and grass. We had

[1] H. T. Gisborne, Chief, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station, died November 9, 1949, while making a study of the Mann Gulch fire on the Helena National Forest, Mont., in which 13 men lost their lives on August 5.

Mr. Gisborne was internationally known for his pioneering work in measuring and rating weather factors which influence the behavior of forest fires. He developed the system of measuring humidity, fuel moisture, precipitation, and wind velocity which can be translated into numerical terms of fire danger, known as the forest fire danger meter. He designed weather instruments now widely used on forest fire weather stations.

In November 1947, Secretary of Agriculture Clinton P. Anderson personally presented Mr. Gisborne with a silver medal emblematic of superior service to the Government, in recognition of his great achievements during the past 25 years in forest fire control research.

[2] Nothing in this report can be interpreted to minimize the danger of forest fires from people smoking in the woods, either on foot, horse, or driving through them. Millions of cigarettes are smoked and flipped by such people. Even if the chances are 500 to 1 against ignition, careless smoking can and does cause thousands of fires each year.

no facts, however, as to what would happen to any hot smoking materials thrown from an airplane. So on October 26 Fred Stillings rounded up enough smoke jumpers to corral a fair-sized fire, and with 3 men in the plane to do the smoking, and 6 or 8 of us on the ground to see what came down, we made some tests at Hale Field in Missoula. A dozen halves of 5-cent cigars and 40 good cigarettes were lighted and thrown from the plane.

With the plane flying at about 120 miles per hour and 500 feet above ground, we could see both the half cigars and the full cigarettes coming down; but when the stubs were thrown out at 1,000 and 2,000 feet, that was very difficult. Furthermore, the condition of 2 of the cigars recovered indicated that either the impact of the 120-mile wind or a hard bump against the fuselage or tail surface of the plane may have torn some of the stubs into small bits. We recovered only 3 of the 12 half cigars and only 25 of the 40 cigarettes thrown out. Of these, all 3 cigar stubs were hot enough to burn holes through the paper toweling on which we tried to catch them. Twenty of the 25 cigarettes recovered, or 80 percent, were likewise hot when caught or picked up.

The condition of some of the hot cigarettes was perhaps significant. The tobacco was burning back inside the tube of paper, which itself was not even scorched on the outside. This may have been due to the cool temperature and moderately high humidity of the hour when we made the tests. It may be, too, that the cooling of the paper surface even when falling through hot, dry air is sufficient to keep the paper from heating to the ignition temperature. Whether or not this adds to the ignition danger is anybody's guess. It seems evident, nevertheless, that the hot coal being inside the paper tube is thereby prevented from breaking off on landing, and then falling down into the duff or grass where its heat is most effective.

Our pilots pointed out one other significant fact, to wit: Even if the plane has a door or window which can be opened, it is not only difficult to open the door against the slip stream but it is dangerous to the plane. Most pilots will be quick to realize that the hot ember may be blown back into the plane or may lodge in a point in the tail assembly and cause damage. The chance of the ember being blown back into the plane was demonstrated in our tests by Floyd Bowman's pants. His wife had to darn four or five holes burned in them.

From these few preliminary tests the answer to Mr. Johnson's question appears to be: Yes, lighted material thrown from a plane can ignite forest materials. But the chances are very small if the ember lands on any material except dry, rotten wood.

MECHANICAL FIRE HAZARD REDUCER

Ed Ritter

Forester, Region 7, U. S. Forest Service

A firm at Fitchburg, Mass., has manufactured and put on the market a portable wood chipper which has created considerable interest in the Northeast. Some of the models may be mounted on light trailers although others are built for mounting on trucks so that "progressive" chipping might be made easier. Cutting blades are of five sizes: 5, 6, 9, 11, and 14 inches. The one I observed was being tried out by the Connecticut Park and Forest Commission. It had a 6-inch blade, was mounted on a light trailer, and was powered by a Wisconsin air-cooled, four-cycle, V–4 motor. I was told by a representative of the company that this machine retails for $1,970.

Figure 1.—Portable wood chipper in use. Chips may be blown 15 or more feet from machine to remove debris from roadway or direct into a truck for carting away.

Wood chips might be used for a variety of purposes, such as mulch for strawberry plants, bedding in dairy barns, poultry and hogpens, and as a source of compost material. Highway crews could make use of a chipper in disposing of brush along rights-of-way. Recreational

maintenance crews might use chips in stabilizing slopes and sandy light soils when heavy use tends to churn up the ground. However, my principal interest in a chipper lies in its ability to dispose of brush as a fire-hazard reduction measure.

Ordinarily, there is little need to burn or otherwise dispose of the usual accumulation of hardwood brush. Coniferous material is more hazardous and is often burned during safe seasons. The 6-inch chipper observed in operation literally "eats up" soft or hardwood brush and slash up to 4 inches in diameter. Chips may be blown into a truck and hauled away or scattered along the roadside as the operator chooses.

My observations have not been sufficient to determine what the cost might be as compared to piling and burning or other means of brush disposal. But considering the soil-building possibilities and various other uses of wood chips, the net cost chargeable to fire-hazard reduction might be fairly reasonable.

Corrosion of Metals by Wet Water.—One of the problems encountered in using wetting agents is increased corrosion in fire-fighting equipment. An experiment conducted at the California Forest and Range Experiment Station shows that a readily available chemical can be used to reduce corrosion.

The test was made to determine the corrosive action of wetting agents upon 24-gage iron and galvanized iron. These metals were selected because they are used in construction of tanks for back-pack pumps and for some fire trucks. Strips of the metals (½ by 4 inches) were cleaned, weighed, and immersed in test tubes containing wet water solutions. Potassium dichromate, a known inhibitor of corrosion which does not affect wetting properties, was added to four test tubes, two with water and two with an agent. Each received 300 parts per million of potassium dichromate (about 0.04 ounce per gallon). At the end of one month the strips were removed from the solutions, cleaned, and weighed to determine corrosion losses.

Tests with iron and 13 wetting agents revealed that 6 of the agents had higher corrosion losses than plain water. Some of these agents may contain inhibitors; one that is known to contain a dichromate salt had a corrosion rate lower than water. Adding potassium dichromate to plain water reduced its corrosion rate on iron by 10 times. This inhibitor reduced corrosion of one of the tested wetting agents by about 10 percent.

Tests with galvanized iron revealed that all but 3 of the 13 wetting agents had higher corrosion rates than plain water. Potassium dichromate was very effective in reducing the corrosion rate on galvanized iron. The agent known to contain a dichromate salt had a corrosion rate three-fifths of that for water alone. Adding potassium dichromate to plain water reduced its corrosion rate on galvanized iron by 5 times. Most important, this inhibitor reduced corrosion of one of the tested wetting agents from twice that for plain water to two-fifths that for water.

In general, it was found that galvanized iron is more readily corroded by wetting agents than is the iron. The zinc coating probably reacts more easily with the chemicals in the wet water solutions.

The test indicates that corrosion rates increase with increase in acidity of the solutions. Adding potassium dichromate to plain water or to a wetting agent solution increases their acidity; but due to the formation of a protective coating by the dichromate, corrosion is decreased. One precaution must be observed when using potassium dichromate—it is a poison, and water treated with it should not be used for human consumption.—Robert S. McBride, *California Forest and Range Experiment Station.*

HELICOPTERS AND RADIOS ON THE STANISLAUS NATIONAL FOREST

Allen F. Miller

Forest Supervisor, Stanislaus National Forest

The effective use of helicopters can be greatly increased by close coordination with radio. This was demonstrated on the Walton Spur fire on the Stanislaus National Forest during August 1949. The equipment used was a Bell two-place (pilot and passenger) helicopter, and KUT2-KUR, UT-UR and SX-type radio.

The fire burned in the steep inaccessible Tuolumne River Canyon at the mouth of the Clavey River. Elevations on the fire ranged from 1,200 to 3,500 feet. Jawbone Ridge, a steep narrow divide between the Clavey River and the main Tuolumne River, was inaccessible except by foot travel through heavy brush.

It was possible to get to the top edge of the canyons by road, but travel into and out of the steep rugged canyons was by foot. This foot travel was slow and dangerous. The fire was handled in two parts because of the inaccessible canyon, but the radio communication enabled one helicopter to service both parts.

Both the Clavey and the Tuolumne Rivers were low at the time of the fire and numerous sand bars were exposed. These sand bars were later used as landing spots for the helicopter. Landing spots were also prepared around the perimeter of the fire and on Jawbone Ridge. Once these landing spots were developed, movement of men became quick and effective. Travel by helicopter from Walton Spur spot No. 1 to Groveland spot No. 2 required 10 minutes. The same trip by car required 2½ hours. Five men were moved in five trips from Walton Spur spot No. 1 to Jawbone Ridge spot No. 3 in 38 minutes. Travel by car and foot would have required 2½ hours. The last 2 miles on foot would have been through steep brush country. By using the helicopter, the men were fresh upon arrival on the fire. On another occasion, 22 men were moved in 72 minutes to Jawbone Ridge. It required slightly over 3 minutes for a round trip. Each man carried his own fire-fighting tool and when he arrived on Jawbone Ridge, he was fresh and ready to work. He only had to walk a short distance to the fire line and went to work immediately. The first man was on the fire in 3 minutes and the crew was built up rapidly. The travel time by truck and foot would have required more than 2 hours.

All direction of the helicopter was by radio. KUT2-KUR sets were placed at all operating landing spots near the fire camps and SX sets were used on the isolated spots. One UT-UR type was used in the Bull Meadow fire camp A. The helicopter was not equipped with radio. The first man to land on an isolated spot carried a radio, and communication was immediately established with his home base. This

proved very useful as it was possible to determine the needs of the crews and to return the crews when necessary. It avoided long delays or unnecessary trips by the helicopter to contact these isolated landing spots to determine needs.

By having radio communication between the landing spots, the helicopter was shuttled between spots to accomplish needed missions and there was very little stand-by time. The helicopter was on the fire 6 days and there was a possible flying time of 63 hours and 53 minutes. It actually flew 44 hours and 5 minutes or 69 percent of the time. There were only 3 hours and 7 minutes of stand-by time. The rest of the time was spent refueling and repairing the helicopter and feeding and resting the pilot.

The helicopter-radio combination was used very effectively in removing a badly burned man from the fire line. The accident occurred about midway up the steep canyon slope. An SX radio was

LEGEND

—— Main Road
- - - Secondary Road
▬ ▬ Fire Boundary
▲ Fire Camp
★ Primary Helicopter Landing Spot
▪ Secondary " " "

FIGURE 1.—Walton Spur Fire on the Stanislaus National Forest, August 1949.

sent to the crew aiding the injured man. They decided to move the man down to the river to a sand bar and have the helicopter transport him to the hospital at Sonora. They radioed that they needed a stretcher. One was dropped to them by the helicopter. The progress of the crew was reported by radio to the Groveland fire camp B as they made their way toward the river. Steep rocky bluffs near the river stopped their progress until 300 feet of rope could be dropped to them. When they reached the river, the helicopter was waiting for them and the injured man was immediately transported to the landing spot near Groveland. The doctor had advised against transporting the injured man to Sonora by helicopter because of the danger from shock.

Late on the fifth day of the fire it was decided to burn out along the Clavey River on the Jawbone Ridge side. Men were flown to a sand bar in the Clavey River and stationed along the river bank. Then lighted fusees were dropped from the helicopter and completed the burn-out. Of 17 fusees dropped, 15 set backfires. One landed on a rocky ledge and the other was snuffed out by the fall.

A planned system of landing spots located on strategic points throughout the forest would greatly increase the early effectiveness of the helicopter. These spots should also be radio-checked with the forest radio net, and all other things being equal, selected on the basis of their radio suitability. A radio set in the helicopter would be desirable, but not essential.

With careful correlation between helicopter and radio, the effectiveness of both these tools in fire control can be greatly increased.

INDIVIDUAL SUBSTATIONS FOR MAIN OFFICE RADIO

Chester E. Lyons

Engineering Aide, Communications, Deschutes National Forest

After our initial installation of FM radio on the Deschutes National Forest, Bend, Oreg., we soon became aware that a remote unit for the administrative assistant and one for the fire assistant did not provide good communications. Often they were left unattended or turned so low that calls were missed. Nearly as bad were the work interruptions as people leaned over the desks to use the sets. We use radio the year around to contact two of our ranger stations, and our

Figure 1.—The remote unit set-up is bolted to a concrete slab; the ship doors are bulletproof.

timber-sales program is quite active. With radios on nearly all lookouts and a fair-sized fleet of mobile radios and portable sets, the unceasing "yammer" from the two remotes became a real problem.

We solved the problem by putting one of the remote units on the receptionist's desk, and from this point wired substation sets to the supervisor, administrative assistant, fire assistant, and the timber management, clerk, and engineering personnel. Each of these substations was provided with a buzzer signaling circuit. The second remote unit was not used.

FIGURE 2.—The remote unit; buzzer system buttons on right of panel; risers have been added to handset cradle so push-to-talk switch will clear.

Briefly, our set-up consists of a 50-watt Motorola transmitter that, with the receiver, is housed in a steel box located some 3 miles out of town on a rocky knoll (fig. 1). A 500-ohm telephone line connects the main office remote unit with the set. Another remote unit is wired in parallel across the 500-ohm line to the ranger's office in another building.

The development of the substations was shelved, twice. At first it was discarded as impractical—too many unshielded leads in conduit under the floor, prohibitive cost, and plain unorthodox practice. We picked up the idea again, only to be stopped cold by the cost of commercial push-to-talk handsets. Finally, we acquired several condemned EE–8–A Signal Corps telephones and with the handsets from these phones set to work. It was found necessary to install Western Electric F1 transmitter units in the handsets to achieve maximum, uniform output. Some handsets are already so equipped. The receiver units were found to be comparable to commercial products.

In figure 2 the buttons for the buzzer signaling circuit are on the right front of the panel of the remote unit, two switchboard keys

have been installed on top of the unit, and a handset rests in its cradle, also located on top. Figures 3 and 4 show the location and size of the piece of equipment needed to connect the substations to the remote unit. Figure 5 shows a substation fastened to a desk. Both the box and switch hook are used pieces of telephone gear. The new non-kinking cord on the handset was used, as the old original cord was much too long.

Disregarding the wiring for the signaling circuit, three wires are used to connect the substations to the remote unit. The substations are wired in parallel across these three common wires. Probably the most surprising thing about the substation circuits is the fact that no further provision of current is needed to drive the F1 units in the handsets.

The dynamic microphone in figure 6 is normally connected with the "hot side" of the microphone going directly to the grid. The switch on the microphone completes the circuit to ground, closing the relay. Current to energize the microphone comes through a resister in the grid circuit. This explains why the switch Sw 1 is needed. It is a switch to take the dynamic microphone out of the circuit. Without this switch the microphone would be "hot" whenever the relay in the remote unit was closed by a substation handset, picking up random noises, typewriter clicks, and conversation. However, through this same circuit the current for the substations is provided.

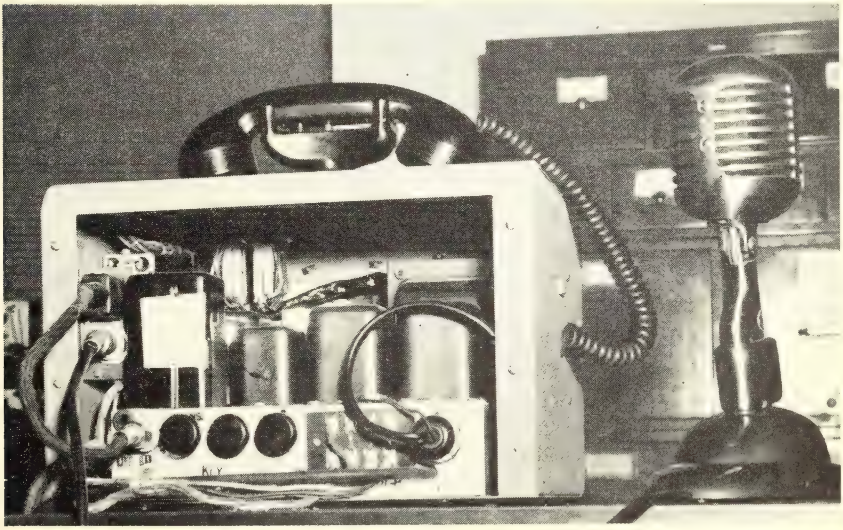

FIGURE 3.—Rear of remote unit with plate removed. Microphone cable goes to added unit. Interunit cable connects added unit to remote unit. Note on relay cover reads, "The only actual change in this remote unit is the removal of a jumper in the Xtal mike plug from # 3 and # 4."

The speaker switch Sw 2 acts as an additional mute circuit. Closing this switch cuts off the speaker, and the signal is heard in the handset even though it is resting in the cradle. The signal heard in this manner is much the same as with any telephone off the hook. It provides ample volume for standby without filling the room full of

sound. The addition of the handset to the remote unit also gives the receptionist a choice of operation. During times when her room has visitors, it allows her to carry on radio conversation as unobstrusively as answering the telephone. For her normal dispatch of traffic, however, she has found the dynamic microphone to be more convenient. The cradle for the operator's handset is wired so that the speaker is cut off and the signal is heard in the handset in the "off cradle" position. (The make-and-break action of the cradle must occur as shown when the handset is in the "in cradle" position.) Both the operator's handset and cradle were manufactured commercially.

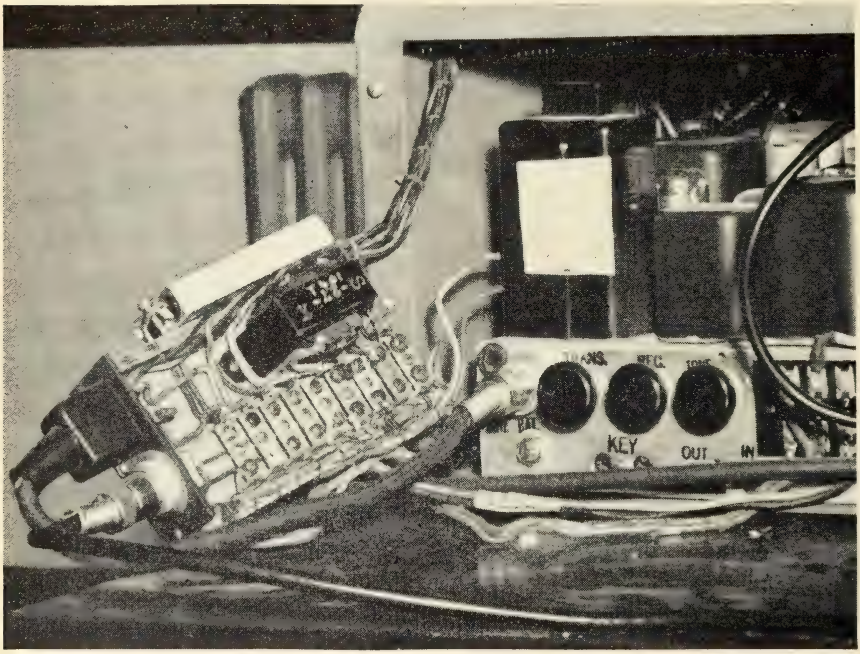

FIGURE 4.—Special unit out for observation. The sidetone condenser is on top. The impedance matching transformer is placed between the condenser and terminal strip.

We rewired the action of the handset as shown and made some revisions in the cradle to get the desired action. However, this handset could have been another EE–8–A handset and mounted in a box. In fact, the microphone and speaker switch, the equipment that connects the remote unit to the substations, could all be installed in some sort of external unit. The interunit wiring is not critical.

The condenser C1, in figure 6 serves the same purpose as the condenser in figure 7. These condensers prevent an accidental DC voltage from spoiling the receivers in the handsets. Condenser C2 however, has an entirely different function. It serves to provide sidetone to the substation system, allowing both sides of a conversation to be heard from any substation handset, thus providing facilities for three-way conversations.

We tried a lot of transformers to properly match impedances, and finally found one among some spare parts with a 1,000-ohm primary and a 35-ohm secondary winding. It matches the external speaker output of the remote unit (terminals 1 and 2) well enough that even with all six of the substations off the hook and in the circuit, no noticeable drop in signal strength is heard. Roughly, this means that twice the number of handsets that we are using could be employed in similar systems. The U. S. Forest Service Radio Laboratory in Portland, Oreg., has the complete data on this transformer.

FIGURE 5.—One of the substations. Old ringer boxes, made of durable hardwood, are fine for size. The condenser, hook-switch, and wiring are inside.

Figure 8 shows a remote unit and two substations complete with buzzer signaling circuit. Note that eight wires are needed to completely connect these three positions. For each additional position, another wire must be added to the signaling circuit. We have four

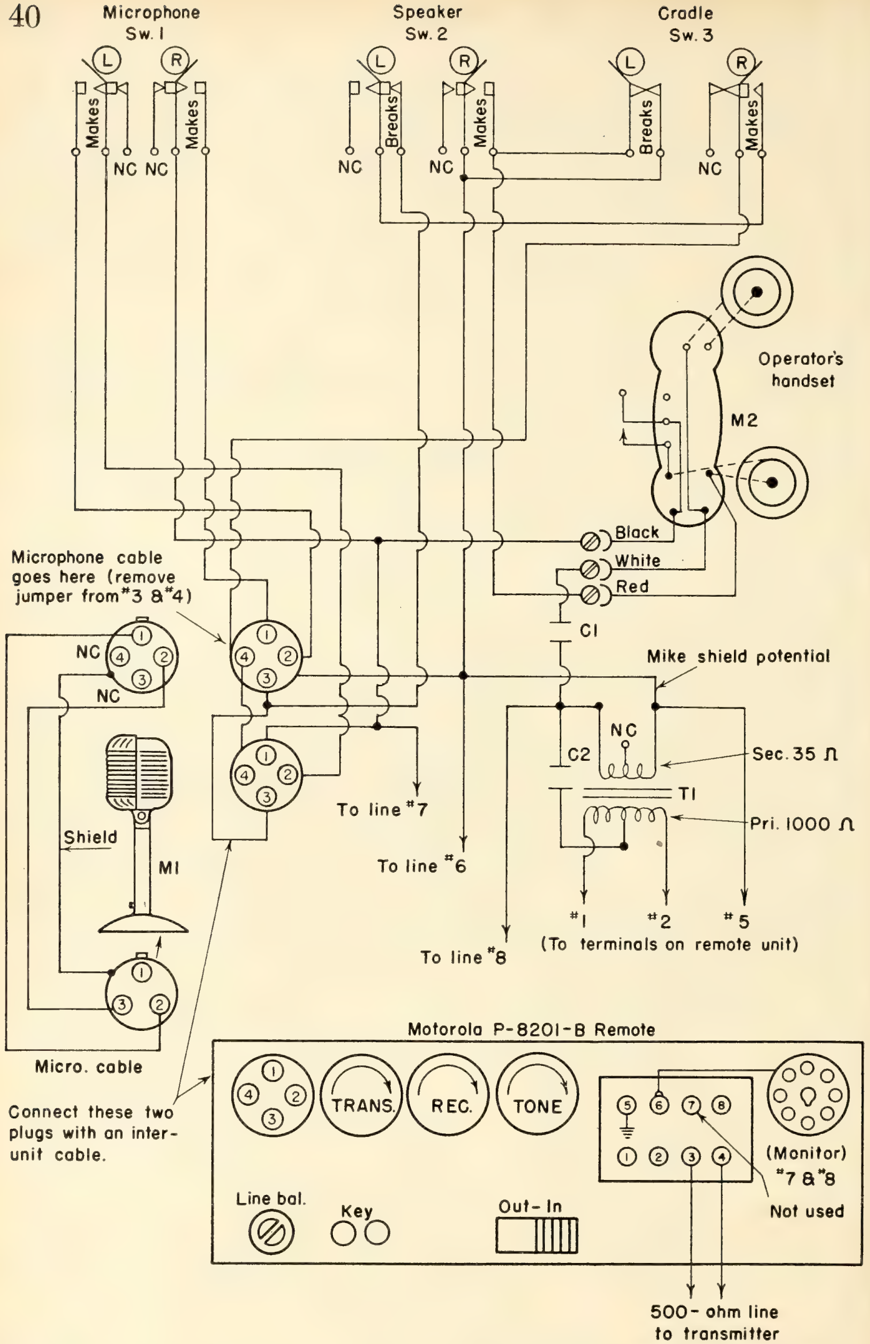

FIGURE 6.—Operator's circuit. Some of the parts are: Sw 1 and Sw 2, key, switchboard "Kellogg" No. 1028; Sw 3, cradle, telephone handset "Monophone" (revised); M1, Model 55 microphone, crystal dynamic "Unidyne" (furnished with remote unit); M2, handset, telephone push-to-talk "Monophone" (revised); C1 and C2, condensers, Western Electric No. 149E 1 mfd.; T1, audio transformer, No. S-27-X (any small transformer with approximately 1,000-ohm primary winding, center tapped, and a 35-ohm secondary winding). Also needed are two female and two male microphone receptacles to make up the interunit cable.

more substations than shown in this diagram; consequently, we use twelve wires in conduit under the floor. The system picks up just enough hum for one to be aware of it when our carrier is unmodulated. It is no more than that and is definitely no trouble.

This system can be hooked up experimentally by any technician using parts from his stock. The wiring of the remote unit is left completely undisturbed. The only actual change that is made to the remote unit is the removal of a jumper wire from terminals 3 and 4 in the microphone plug. The method of adjusting the "Trans" control knob is a little different, due possibly to the condenser C2.

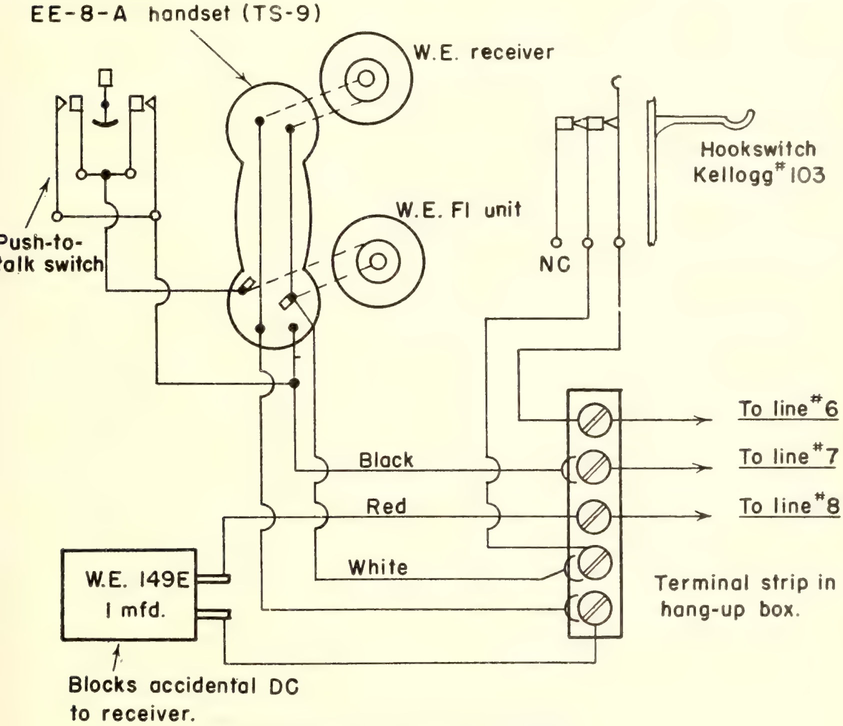

FIGURE 7.—Substation circuit.

Oscillation occurs if the "Trans" knob is advanced too far causing the DB meter to swing off scale and the outgoing signal to be blurred. With the dynamic microphone switched out of the circuit, close the relay in the remote unit by pushing the push-to-talk switch on any of the substation sets or by the push-to-talk switch on the operator's handset. Observing the DB meter, adjust the "Trans" control (handset unmodulated) so that the needle on the meter rests in its normal left-hand position, in other words, so that the needle is quiet. This setting may be found to be too much for the dynamic microphone. If this happens, have the operator speak in such a way as to average zero DB on the meter. It will be about right for the F1 units in the handsets as these will vary with loud and soft voices, distance from

the mouthpiece, etc. Adjust the receiver signal at the remote unit as desired. Adjustments here will not vary the handset signal enough to be noticeable.

The actual cash outlay for parts to complete our whole substation system came to less than 10 dollars. The buzzer system had been installed years before. We rewired it (as shown in fig. 8) in order to use less wires than had been used originally. If substations of this type are contemplated and all parts and boxes must be purchased, the cost per substation will run about 8 dollars. The saving will be appreciable if the cost of a like commercial product is considered. We could find nothing similar for less than 35 dollars each.

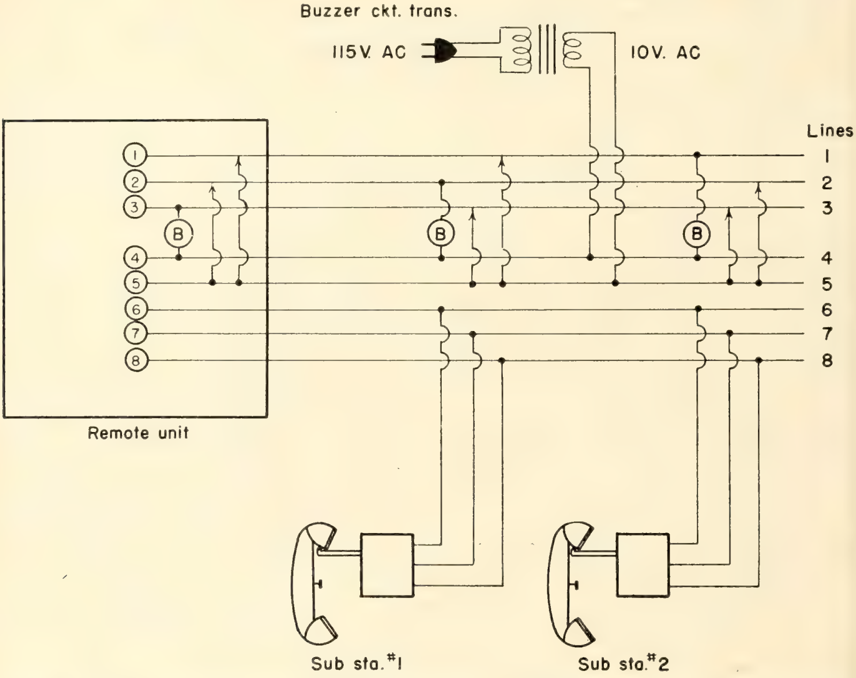

FIGURE 8.—Remote unit and two substations complete with buzzer signaling circuit. The buzzer circuit transformer is an ordinary doorbell transformer.

The buzzer signaling system buttons and buzzers can be obtained almost anywhere. With the exception of the buttons installed on the remote unit (done this way for the receptionist's convenience) our buttons are in little block affairs that go nicely in a drawer. The buzzers are fastened under the desk.

Our substation setup is only one of many variations that are possible. A similar system can be devised to control almost any type of gear.

Further information on this installation may be obtained by writing the author on the Deschutes National Forest, Bend, Oreg. Also, we are interested in hearing from any forest that makes such an installation.

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FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

HISTORY OF SMOKE JUMPING, 1939–49 [1]

DIVISION OF FIRE CONTROL

U. S. Forest Service, Washington, D. C.

'Elapsed time" is the essence of good fire control. Study of time ords of forest fires has shown that travel time, that part of elapsed ne from report of the fire until attack is made, is a major factor ecting the final area of a fire. The final area of many a fire has en rise to the wish "If one man could only have got there early ough!"

'orest officers have given much thought to the problem of reducing travel time to inaccessible or back country fires. As early as 1931 V. Pearson, United States Forest Service employee now retired, ought of using airplanes and parachutes to overcome this time handi-). However, it was felt that the time was not ripe to experiment h this novel idea. Parachuting in those days was not considered something to be planned, but rather as a "last chance" to be used by nan in an airplane just before a crash.

The idea of using airplanes and parachutes to overcome the elapsed-ne handicaps was almost "still born." Nothing was done to keep it ve until 1939 when David P. Godwin, then Assistant Chief, Division Fire Control, took up the idea. Quoting from his article in the oril 1940 issue of the Aero Digest: "Since the beginnings of sys-natic forest fire control, about 30 years ago, men have bent their oughts and energies toward the extension of forest ways and to faster ans of traveling over them. In our National Forests a vast network transportation routes is now maintained. Along those forest ways, foot, by horse and by motor, go the men dispatched to suppress es. On the 23,000 miles of roads, and 137,000 miles of trails, there 20,000 motor vehicles in use by the Forest Service and more are ited in time of need.

'Gradually the extension of roads and the addition of vehicles are wing down as the point of diminishing returns approaches. What en? Will current travel-time achievements become static? There ll be some continuing extension of ground routes and improvement ground vehicles, but the results of this in further reduction of travel ne will become comparatively unimportant.

'On the other hand, if we can intelligently adapt transportation by to our ends, it may open up an era of time-cutting which our present rest fire organization plans have hardly glimpsed. For some years craft have been used in the delivery of fire fighters and fire control erhead from distant centers to nearer centers, and this has been a eat advantage in assembling men for large going fires. We have veloped 76 landing fields, but this is pitifully scant distribution

[1] Condensed from Regional reports.

over the great area of all of the national forests. More can be constructed, but topography will soon limit such extension. Here again the curve of progress will begin to flatten out, rising again sharply with the advent of a heavy pay load carrying craft capable of hovering and of vertical descent and ascent. We then may be able to land aircraft in thousands of small clearings, on beaches, bottoms, and ridge tops.

"So for the present, at least, comes the question 'What can be done to land men without landing planes?' The question is not new. For years fire control men have mused and argued about the possibilities of parachute jumping of individual trained fire fighters near small fires in back country and thus catch 'em early. Is such a travel-time reducing method mechanically practicable, and is the risk to life and limb a responsibility sane forest officers would care to assume?

"Professional parachute stunt jumping has been confined mostly to airports. The Russian and German armies in maneuvers and in actual warfare have made mass jumps of armed men, but always over open, flat, or rolling country. So far as known, however, there have been no premeditated jumps over rough and timbered terrain such as that found in the high back country of our western forests. It looked too fearful from the air. But as often happens, things are not as bad as they look."

These remarks by the late Mr. Godwin are ample evidence that he was among the first to press for the application of parachute jumping to overcome the travel-time headaches of potentially disastrous back country or inaccessible fires. It was through his efforts that experiments in smoke jumping were undertaken by the United States Forest Service in 1939. As far as is known, these were the first experiments designed to determine whether or not delivery of men to inaccessible fires via airplane and parachute was feasible.

Until 1938 all Forest Service flying in the West had been done by army planes or by private contract fliers. In 1938 the Forest Service purchased a Stinson SR–10 fitted out especially for fire control experimental work. This five-place plane was powered with a 450-horsepower P&W Wasp motor. Rear seats and the door on the starboard side were removed and the interior arranged for cargo. This plane was assigned to Region 5 (California) of the Forest Service and used in fire bombing experiments in that area.

Early in 1939 the bombing experiment was transferred to Region 6 (North Pacific Region). David P. Godwin was in charge of the project. He was assisted by Lige Wernstedt representing the regional division of operation and Harold King, Forest Service pilot. During the summer of 1939, the decision was made to abandon the aerial fire bombing project and to devote efforts for the remainder of the fire season, October 5 to November 15, to experimenting in the delivery of fighters to fires via airplane and parachute.

The location selected for the experiment was an airport near the Winthrop Ranger Station, Chelan National Forest, Wash. C. Otto Lindh, Chief of Fire Control, Region 6, had charge of the field work. Other immediate personnel were Beach Gill, collaborator; David P. Godwin, Assistant Chief of Fire Control, W. O.; T. Albert Davies, technician (later project leader, forest officer); Harold C. King, Forest Service engineer pilot; Walter Anderson, fire assistant, Chelan

ational Forest; Frank Derry, head parachute rigger and jumper; hester Derry, jumper. The Eagle Parachute Co. was the successful dder for a contract to provide parachutes, protective clothing, and e services of professional riggers and jumpers.

After a number of dummy tests, about 60 live jumps were made rgely by professional parachute jumpers employed by the contractr. During the concluding days of the experiment several Forest ervice employees were allowed to jump into open fields and timbered eas. There were no injuries of consequence. Here on the Chelan special handle was bolted to the right-hand strut of the plane to able the smoke jumpers to steady themselves while standing on the ep outside the door.

The selected training outfit, consisting of the Eagle 30-foot backck and 27-foot emergency chest-pack canopies with quick detachle harnesses, proved satisfactory. A two-piece, felt-padded suit, otball helmet with wire-mesh face mask, athletic supporter, ankle aces, combined back and abdominal braces and heavy logger boots mpleted the attire of the jumpers and provided protection from e hitherto unknown hazards of timber jumping.

There is no record of any fire jumps during 1939.

Conclusions drawn from the experiment were:

1. Smoke jumpers could land safely in all kinds of green timber ver common to the Chelan National Forest. Its major timber pes—subalpine, lodgepole (mature and immature), mixed north ope Douglas-fir and wastern larch, ponderosa pine and hardwoods—e common to many areas in the western national forests. The experiment thereby proved that jumping could be done successfully in ost of the green timber areas, except those of the tall west coast ouglas-fir and redwood types, providing terrain was satisfactory.

2. Successful jumps could be expected in mountain meadows, open dges, and steep open slopes if boulders were not too close together. levations under 7,000 feet above sea level offered no obstacles.

3. Snag areas, areas of down timber, lodgepole deadenings, exemely steep slopes, deep canyons, and areas of rock cliffs or ledges ould be avoided.

4. Jumpers experienced less fatigue in jumping than would result om a short hike up a steep hill.

5. The denser the stand of timber the easier the landings and the ss shock experienced by the jumpers. Landings in thickets of young ees and reproduction were termed "feather bed" landings because of e manner in which the vertical descent of the smoke jumper was ecked.

6. Retrieving a parachute canopy from the crown of a tree or trees a problem.

7. The ability to steer the type of parachute used contributed eatly to accuracy in hitting the ground target even when ground ind was stronger than 10 miles an hour. Gusty winds are much ore troublesome than stronger steady winds in that the unexpectedss will cause a 200- to 300-foot drift before the jumper can maneuver compensate.

8. The type of parachute used had a natural forward glide in still r of from 5 to 8 miles per hour; this could be used to advantage by cing into the wind, thereby reducing the drift over the ground by a ke amount.

9. There was no evidence of fear or panicky state of mind even in first-time jumpers.

The primary conclusion of the experiment was that delivery of fire fighters to fires via airplanes and parachutes could be done and without injury to the men engaged in such work. This conclusion led to the next phase of the smoke-jumping program; namely, the development of plans for actual operations to be undertaken in 1940. The dreams of many firemen were at last to be realized.

Reports and cost estimates were made, equipment and personnel specification written, equipment and supplies purchased during the winter months. Since this was a new project specifications had to be developed and firms found that would be interested in furnishing much of the nonstandard pieces of equipment. Administration, training, and operation plans were also prepared.

The thoroughness of the preliminary planning by Region 6 personnel was a vital contributing factor to the success and safety record of the experiment. The safety measures then devised have been followed with success as history in following years shows.

1940

Region 1 (Northern Region) and Region 6 each organized a small squad of smoke jumpers for the 1940 fire season through recruitment of the younger men from among their most experienced firemen. Region 6 was fortunate in having two professional jumpers who had gained some experience through the 1939 experiments. The Region 1 squad had no previous training in this type of work.

Frank M. Derry of the Eagle Parachute Co. was retained by the Forest Service to serve both regions during the training season. Region 6's squad of seven men was trained at the Winthrop base in Washington. The project leader from Region 1 also received his orientation there. He then returned to his region to supervise the training of its squad at Seeley Lake about 35 miles from Missoula.

After training the Region 6 squad was stationed at the Winthrop base and the Region 1 squad at Moose Creek Ranger Station, Bitterroot National Forest. The Region 6 squad jumped to only two fires during the season. The small squad at Moose Creek saw action on nine jumper fires.

The first actual fire jump in the history of smoke jumping was made by Rufus Robinson at 3:57 p. m., July 12, 1940, in connection with initial attack operations on the Martin Creek fire, Nezperce National Forest (Region 1). Earl Cooley is credited with making the second actual fire jump on the same fire. They were the only two to jump to that fire. Control was established by 10 a. m., July 13. Of historic note also is the first successful "rescue jump" made by smoke jumper Chester N. Derry 3 days later to an airplane crash on the Bitterroot National Forest.

According to Region 1 estimates the total cost of the smoke-jumping operation during 1940—including personnel, depreciation on equipment, and flying—was $9,047. They estimated that the nine fires controlled by smoke jumpers would have cost $32,270 if ground crews alone had been employed.

On the Chelan in Region 6 a fire at the head of Little Bridge Creek as jumped by Lufkin September 10; a second fire was jumped on wenty Mile Creek, September 11. These two could have been very rious fires costing a lot of money to control except for smoke-jumper tion.

An interesting side light—and one of far-reaching effect—pertains to e visit of four United States military staff officers to the smoke-mper training camp in June. One of them, Maj. William Cory Lee, ter employed Forest Service techniques and ideas in organizing the st paratroop training at Fort Benning, Ga. Major Lee subsequently mmanded the 101st Airborne Division which he took to England and ained for the Normandy invasion. He became first chief of the irborne Command and is regarded as the unquestioned father of nited States airborne doctrine.

High lights of the 1940 season:

1. Smoke-jumping operations were successfully applied to 11 fires.
2. No incapacitating injuries resulted from the 1940 operations.
3. Project Leader Lundregan of Region 1 believed that delivery of illed and well-trained fire fighters by parachute could be done successlly in rough timber terrain in winds up to 30 miles per hour and at titudes up to 8,000 feet above sea level. (NOTE.—Later indicators ointed to maximum velocities of more nearly 20 to 25 miles per hour ith presence or absence of gustiness being probably more important an velocities.)

It was concluded that—

4. Parachuting as an aid to forest fire control would probably not rove economic in forest areas where the road system provides ready ccess for ground forces.
5. Smoke jumpers should be between 20 to 35 years of age and not er 190 pounds in weight.
6. Smoke-jumping operations should continue in 1941.

1941

All smoke-jumping operations were confined to Region 1. Increased nds allowed expansion to a 4-squad outfit of 26 men, including all the jumpers who had served the previous year. One squad was cated at Moose Creek on the Bitterroot, one at Big Prairie on the lathead, and one at Nine Mile Camp a short distance from Missoula. hirty-four jumps were made on nine fires—three on the Chelan, two the Bitterroot, one on the Lolo, and three on the Flathead. Some the jumps on the Chelan National Forest were several hundred iles from the operating base.

Region 1 stated in its report, "An impartial reviewer of the season's re control activities would have to admit evidence shows that we issed the boat' in a few cases." Supervisor Harris of the Chelan rote: "Conditions seemed too favorable to justify smoke jumpers the outset on the Route Creek Fire. 'Back sight' now points out early that smoke jumpers would have saved $12,000 in suppression osts. With our 'easy season' in Region 1, we cannot point to any net robable savings, but it appears that we may have been a little slow ordering out the jumpers on at least one fire which eventually ran nto money."

Estimates for the season indicated that the ratio of benefits to costs was about 10 : 1 or about $33,875 to $3,410 on nine fires. This estimate indicated the need for a system of selection that would assure the use of smoke jumpers on fires that have major conflagration potentialities.

Important developments of the season:

1. A static line adapted to the Eagle back-pack and used throughout the season. This device, which eliminates the manually controlled rip cord, appeared to have a remarkable effect on the trainees; it reduced the intensity of nervous reactions that generally precede first fire jumps.

2. Dr. L. P. Martin of Missoula, locally known as the jumping doctor, continued his jumper training and expressed his willingness to make parachute jumps to injured or helpless individuals in the back country. This resulted in a plan for a jumping squad to be available to render first aid in inaccessible areas.

3. The Ford Tri-motor and Curtis Travelair type airplanes proved admirably suited to smoke-jumping operations.

4. For the first time an organized force was jumped to a threatening fire that had escaped from the initial attack forces and had reached an area of 15 acres in very bad fuels. The jumpers were able to hold the fire in check until additional ground forces arrived.

5. Accidents due to jumping can be held within an acceptable tolerance ratio.

6. It was demonstrated that smoke jumping is a practical possibility.

1942

The project continued in Region 1, and location of the squads was the same as in 1941—Moose Creek, Big Prairie, and Nine Mile Camp. A further expansion led to a 4-squad unit and only the impact of World War II prevented greater development. Because of the war, age limits and experience requirements had to be liberalized though physical standards were not lowered. Training was undertaken with but 5 experienced men. Of the 33 recruits to be trained only a few were experienced smokechasers. This necessitated a greatly intensified program of fire control training in addition to the jumper training.

The equipment situation was very critical. Occasionally a few chutes not acceptable to the Armed Services were obtained and converted. Experimentation resulted in an outstanding development in aerial fire control—the Derry slotted chute. This chute is easily opened and maneuverable, and provides a slow descent and better oscillation. It was found that any standard, flat-type parachute could be converted by adding slots and guide lines.

Thirty-one fires were jumped by smoke jumpers during 1942. The savings in suppression costs were estimated to be $66,000 because the fires selected for the jumpers were potentially bad ones. As in previous years, accidents were few and were therefore not considered to be a bar to the future of the program.

1943

The manpower shortage had reached a very critical stage, and only five experienced jumpers returned to the project. Inquiries were received from 4–E draftees (conscientious objector) in Civilian Public

ervice (C. P. S.) camps who wished to secure noncombat work of
ne nature afforded by smoke jumping. Sixty candidates were select-
d, a majority of whom were from the "peace churches"—Mennonite,
rethren, and Friends.

Regions 4 and 6 reentered the project with Region 1, each sending
re control men to Missoula to be trained as squad leaders and riggers
serve as overhead for C. P. S. squads that would be assigned later.
acilities for training were enlarged at Seeley Lake by the addition
f an obstacle course, a plane mock-up, and some lesser improvements
equipment. About 70 new men were trained during the 1943 season
nd again there were no failures. However, a few received minor
njuries in training which prevented them from jumping to fires
uring the summer.

The smoke-jumper program for the summer involved 4 squads or
8 men for Region 1, 1 squad or 11 men for Region 6, and a 5-man
quad for Region 4 (Intermountain)—a total of 64 men. The Region
squad, under the direction of Jack Heintzelman, was located at the
edwood Ranger Station, Siskiyou National Forest, Oreg.; the Region
squad was stationed at McCall, Idaho, Payette National Forest;
nal distribution for Region 1 was 12 men each at Seeley Lake, Big
rairie, Moose Creek, and Nine Mile Camp.

Thirty-one fires, involving 94 individual jumps, were recorded for
egion 1 squads, 6 fires for Region 6, and a few fires for Region 4, for
season's total of about 40 fires.

An indicated savings of more than $75,000 is attributed to the use
f smoke jumpers on fires in 1943.

High lights of the 1943 season:

1. Training of parachute rescue units involving 25 men from the
nited States Coast Guard, Canadian Air Observer Schools, and
nited States Air Forces. About half of the men trained were flight
urgeons.

2. The Derry slotted chute proved successful and popular with the
umpers.

3. Conscientious objectors were used to advantage as jumpers.

4. Again, accidents did not prove a bar to continuance of the
rogram.

1944

C. P. S. men continued to be the reservoir of manpower for the
roject, with nearly 60 percent of 1943's group returning. Distribu-
on of the men was about the same as in 1943 but with changes in the
umbers of jumpers assigned the 3 regions. Approximately 120 men
ook part in the program. Training of the new men continued to be
onfined to Region 1, as was most of the refresher training of the
xperienced men.

A further centralization of smoke-jumper use in Region 1 led to a
hanged arrangement of forces at the various bases. A stand-by unit
as held at Missoula; the number of the men in the squad could be
aised according to potentialities of use by drawing from outlying
eeder bases where 40 to 50 jumpers were kept, many on work of
roject nature.

There was a considerable increase in smoke-jumper use in 1944.
early 100 fires were handled—about 75 percent from the Missoula

base. Jumpers were used on larger fires than previously and in larger groups. Substantial suppression savings were made.

Important developments in 1944:

1. Smoke jumping was no longer on an experimental basis; it was considered as a routine operational feature of the over-all fire control job in Regions 1, 4, and 6.

2. Smoke jumpers were used in Region 5 for the first time. They jumped to one fire on the Happy Camp District of the Klamath National Forest.

3. A method of guideline attachment allowing faster and easier manipulation of the canopy was developed, tried out, and pronounced successful.

4. A new simplified technique in let-down from trees was perfected.

5. Perhaps the most significant change was in Region 1 where parachute jumpers were included in the regular organization. Previously, the smoke-jumper unit was organized as a special force—an adjunct to the ground forces, financed from special funds. Some national forests for the first time reduced the number of back country smokechasers, thus becoming wholly dependent on smoke jumpers over considerable areas.

6. Nineteen hundred and forty-four was the first year in which considerable use was made of military aircraft for smoke jumping in Region 6. In Regions 1 and 4 Ford Tri-Motor and Curtis Travelairs continued to be the mainstay for smoke-jumper transportation.

7. Continued low-accident rate in smoke-jumping operations proved the safety measures observed and intensive training of smoke jumpers were successful and that the program could be expanded, if necessary, without particular worry concerning accidents.

1945

Nineteen hundred and forty-five was the last of the war years. Continued expansion of the C. P. S. program and the return of war veterans permitted an increase in the total number of smoke jumpers in the 3 regions to about 220 men, of which nearly 100 were seasoned smoke jumpers. Training of new men and most of the refresher training of the returnees was conducted under the direction of Region 1 at the Nine Mile Camp out of Missoula.

Distribution for the season resulted in increased quotas of jumpers: Missoula, Mont., 153; McCall, Idaho, 36; Twisp, Wash., 15; and Cave Junction, Oreg., 15. The 153 men were not actually located in Missoula. Missoula was used as a base of operation to which smoke jumpers could be brought as the need developed.

Use of smoke jumpers was very high during the period July 11 through the first week in September. In the 3 regions smoke jumpers were used on 265 fires involving 1,236 individual jumps. These jumps were to potentially serious fires on 23 national forests in Montana, Idaho, Washington, Oregon, and California, and to fires in Yellowstone and Glacier National Parks, United States Indian Service lands, and private timber association lands. Also, the first jump by smoke jumpers over the international boundary in Canada was made.

A partial analysis of suppression costs indicated a savings of $347,-)0 for the season's operations.

Most significant events in 1945:

1. First experimental "Air Control Area" [2] involving 2 million acres f roadless wilderness. This area included parts of the Flathead, ewis and Clark, Lolo, and Helena Forests in Region 1, and became nown as the Continental Unit. Aerial detection and smoke jumpng almost to the exclusion of ground forces work were used.

2. Additional training of military men in parachute work pointed aerial rescue operations.

3. First active collaboration of smoke jumpers and army paradoctors 1 rescue missions. Air-rescue jumps for the season were 55.

4. Training of the 555th Battalion of Negro paratroops in timber mping and fire fighting to combat Japanese balloon fires. Ninetyeven Negro paratroops were jumped on the Bunker Hill fire and 28 1 the Heather Creek fire, both on the Chelan. Regular smoke jump-rs were used as overhead. In addition, 6 made jumps on the Rattle nake fire, 10 on the Lemon Butte fire and 4 on the Copeland Creek re, all on the Umpqua National Forest.

5. The loan of two UC–64 Noorduyn Norseman airplanes from Army)r use in Region 6.

6. Standardization of (1) qualifications of men selected as smoke mpers, (2) training technique, (3) jumping gear, such as paraıutes, suits and other rigging, and (4) jumping technique.

7. Air transportation demonstrated as a quick and effective means f placing skilled, hard-hitting crews on fires that might otherwise rove serious, and also for placing additional forces on fires escaping itial attack crews.

8. The testing of quick-release type harness. This harness had lvantages over the old type since it simplified "tree let downs" and as designed to fit any size man. Regions changed over to this type f harness in 1948.

1946

With the end of the war, the C. P. S. program was liquidated. Only small group of trained smoke jumpers remained, and it was necessary)r the regions to recruit large numbers of civilians to be trained.

The over-all number of jumpers and their distribution to operating ıses remained about the same as in 1945. Of Region 1's group of)out 160 jumpers, 84 percent were ex-service men and about 40 per-ent were college students, many taking up forestry as a career. The ellowstone and Glacier National Parks and the California Region ırticipated financially for the first time in the program.

A C–47 airplane was added to the contractor's fleet making it pos-ble to transport larger crews at greater speed.

Three hundred and twenty fires involving 1,111 individual fire mps resulted from the 1946 operation. This was an increase of 51 res over the previous year.

Savings attributed to the Region 1 part of the operation (202) res was $376,000.

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[2] For further information see FIRE CONTROL NOTES 1947, vol. 8, No. 1, pp. 28–32.

1947

There was no radical change in the operational features of the program or in the number of jumpers employed. Of interest, however, was the degree of turn-over; about 50 percent of the previous year's men returned. This helped to reduce the job of training. The season was less severe than that of either 1945 or 1946. Consequently fewer fires were attacked from the air. A total of 932 individual jumps were made on 192 fires.

High lights of the 1947 season:

1. Regions 4 and 6 developed their own training centers and conducted their own parachute training.
2. A foreman and eight jumpers from Region 1, with a Noorduyn Norseman plane and pilot from Region 6 were detailed to the Gila National Forest in Region 3 (Southwestern) for the period May 25 to June 25.
3. The use of helicopters to retrieve smoke jumpers and return them to interior airfields or other locations of immediate access was considered seriously for the first time. With this plan in view, experiments were conducted in Region 5 during the season.
4. David P. Godwin, who fathered the smoke-jumping operation during its initial phases and throughout the following years, died in a commercial airline crash in the Virginia mountains on June 13.
5. Smoke jumpers from the Missoula base participated in combined attacks on two fires that were bombed from the air as a part of the Forest Service-U. S. Army cooperative fire-bombing project.
6. Two groups of Air Rescue Service were trained as jumpers at the Missoula base.

1948

The number of smoke jumpers increased from 225 in 1947 to 244 in 1948, mainly because more jumpers were employed in Regions 4 and 6. The groups at Cave Junction, Oreg., and at the Inter City Airport (near Twisp, Wash.) on the Chelan National Forest each employed 28 men. A new unit of 10 men was added to the Region 4 set-up and stationed at Idaho City, Idaho, on the Boise National Forest. Region 5 entered the program by financing a leader and 3 jumpers, who were stationed on the Siskiyou National Forest and supervised by Region 6.

The 1948 fire season in the West was the lightest in many years, except in Region 3 where a severe season was experienced. One hundred fires involved but 402 individual fire jumps during the season's operations.

High lights of the 1948 season:

1. Helicopters were used for the first time to return smoke jumpers from back-country areas to places of immediate access. The first use of a heliocopter for this purpose was on July 30 and involved the Cedar Camp fire on the Klamath National Forest in California. All six jumpers with their equipment were moved out after being replaced. Two other fires jumped in Region 5 involved transportation out by helicopter. Nine smoke jumpers and gear were retrieved in this manner for the first time on the Chelan on August 4.
2. Special lengthy reports were eliminated because smoke-jumping operations had become generally accepted as routine.

3. Helicopters were used for the first time by Region 6 for initial tack on the Snoqualmie National Forest.

1949

There was very little increase in the number of smoke jumpers emoyed in 1949, and operational procedure remained about the same. egion 1 had 150 jumpers with the primary base of operations at issoula, Mont.; Region 4 had 11 jumpers at Idaho City, Idaho, and at McCall, Idaho; Region 6, 28 at Cave Junction, Oreg., and the me number at Inter City Airport, Wash.—a total of 252 men. The man unit from Region 1 was again detailed to the Gila National orest in Region 3 during May and June. Region 5 financed 8 men om the Siskiyou, Region 6, to serve the needs of 5 northern Calirnia forests.

There were 354 fires jumped in 1949, involving 1,335 individual mps. This was the largest number of fires and the greatest number jumps since initiation of the program in 1940. The estimated savgs in suppression costs exceeded $900,000 for the season.

Helicopters were used on more fires to return smoke jumpers to ints of immediate access than during 1948, principally in Region 5 here four fires were involved. Initial attack was made by helicopter fires in Region 1 and the Wallowa in Region 6—a small beginning, t a gain in experience in the use of this craft.

Summary of Smoke-Jumping Activity 1940–49

Year	Smoke jumpers	Fires jumped	Average fires jumped per crew	Individual fire jumps	Average men per fire	Average fire jumps per man
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
40	14	9	0. 64	[1] 27	3. 00	1. 93
41	26	9	. 34	[1] 30	3. 33	1. 15
42	32	31	. 99	[1] 100	3. 22	3. 12
43	64	40	. 62	[1] 130	3. 25	2. 03
44	120	100	. 83	[1] 350	3. 50	2. 91
45	219	269	1. 23	1, 236	4. 60	5. 64
46	229	320	1. 40	1, 111	3. 47	4. 84
47	225	192	. 86	932	4. 85	4. 14
48	244	100	. 41	402	4. 02	1. 64
49	252	354	1. 39	1, 335	3. 77	5. 29
	1, 425	1, 424	1. 00	5, 653	3. 96	3. 97

[1] Estimated.

RANGER DISTRICT ORGANIZATION ON HIGH DANGER DAYS

Paul M. Kihlmire

District Ranger, Clark National Forest

The fire presuppression job which makes large demands on the ranger's time is the preparedness and organizational planning on high fire danger days. This planning supplements the annual fire plan and all the other guides used in fire control. It concerns the day-by-day and hour-by-hour maneuvering as fire danger builds up and continues high over several days.

The planning starts the afternoon and night before anticipated high danger days and is a continuous action over sustained high danger periods. Initial plans are made by the ranger during early afternoon, expanded and fully developed as soon as possible the same night by the ranger and his staff. These plans include:

- Weather reports.
- Follow-through action.
- Regular personnel.
- Lookouts.
- Fire crews.
- Equipment (mobile and special).
- Fire tools.
- Food and supplies.
- Overnight watch and fatigue plans.
- The situation.

Weather reports.—Assemble all weather reports received by dispatcher during the day and correlate with special weather information relayed from the supervisor. Check these reports against local radio and newspaper forecasts. This data will give a trend and is used to calculate probable fire dangers. The anticipated danger becomes the basis for adjustments in the fire control organization to meet the change in conditions.

Follow-through action.—Secure data on all reportable fires, false alarms, and nonstatistical fires for the period. Estimate the mop-up and patrol job as carry-over suppression work to be dovetailed into the plans for fire inspections and fire investigation. This information gives the pattern for assignment of regular personnel and the need for supplementing this personnel with outside help.

Regular personnel.—Each of the regular personnel is given an assignment for the following day. His geographical location is definitely determined and his means of communication with the dispatcher established. Each man is assigned a piece of equipment and has a specific fire job to perform. On large fires each man has a special assignment to best utilize his abilities in the large fire organization. This is also true in the high danger day organization where the placement of personnel is determined by fire occurrence, fire mop-up and inspection, fire investigation, and the distribution of fire tools, food, and supplies.

Lookouts.—The tower-manning requirements are reviewed in line vith expected weather, visibility, and period of time the towers have een manned. Secondary towers may be needed and the personnel to nan them mobilized. Alternates for the regular lookouts are necesary to rest the regular towermen. The normal morning check-in ime and the night check hour may be changed to meet local conditions uring high fire danger. (Experience has proved a 10 p. m. night heck may be much more effective than an 8 p. m. check the night of pie supper or revival.) Windy nights require all-night detection nd dispatching.

Fire crews.—Determine number of fire wardens and fire fighters eeded for the anticipated danger for the following day. Request for pproval on needs beyond authorization. Send orders to wardens on ize of crew wanted, where to report, and work assignment upon reorting. Consider the current day's work by fire crews to keep initial ttack force fresh and effective mop-up jobs completed early. An aditional task on these days is expansion of mobilization to include eldom-used wardens and the hire of additional equipment.

Equipment (mobile and special).—This phase of the planning inludes the placement of equipment and personnel assigned. Tankers nd plows are located for initial attack determined by terrain, fuel ype, risk, and accessibility. Follow through on operating condition nd readiness for call.

Fire tools.—Needs of fire crews and means of delivery scheduled. Varehouse fire-tool replacements are requisitioned currently to mainin the authorized fire-tool complement. Inspection of fire-tool mainenance and distribution assigned.

Food and supplies.—The dispatcher keeps a want list for food, ations, and miscellaneous supplies needed by wardens, lookouts, and eld crews. Purchase and distribution is scheduled and assigned to egular personnel, except on large fires where a separate service of upply is set up.

Overnight watch and fatigue plans.—Plans are made for alternate ispatcher or at least telephone operator to take night calls when towers re manned all night. One of the regular personnel is assigned to be alled when action is needed. Both days and hours are staggered as uch as possible to keep fatigue at a minimum.

The situation.—The planning action is summarized and a report elephoned to the forest supervisor. Approvals are secured and any hanges for forest-wide fire-control needs are incorporated into the rganization for the district.

Briefs for newspapers and press releases in outline form are made eady since all information is available.

This check-list planning gives the administrator the pulse of his rganization. The staff conference, informal and short, enables the egular personnel to report on the effectiveness of the various wardens, ow the fire crews performed, elimination of "goldbricks," and the ver-present job fire possibility. The total work load can be equalized; bove all it is an ideal time to break down the tension of high fire anger.

FIRE FIGHTING ORGANIZATION AND WARDEN SYSTEM

Gifford B. Adams

District Ranger, Clark National Forest

[Following is the district organization with emphasis on the fire-warden system to effect economical fire control.—Ed.]

District ranger (full time).—Free to carry on other field duties, either fire or project, except when a fire situation develops, or on days of high fire danger. In touch with dispatcher or tower by radio at regular call times. Takes initial action when feasible. Usually takes charge of first large fire, and worst fire when several serious fires are going. In touch with dispatcher by radio to correlate over-all fire picture. Is accompanied by five- to six-man fire crew during high danger days.

Forestry aide (full time).—This employee is dispatcher approximately 90 percent of the time. He does most of the dispatching on high danger days and during bad fire situations. He is assigned to enough fires each year, as fire boss, to keep in touch with actual fire fighting and to keep oriented on crew capabilities, communications, and other field conditions indispensable to efficient dispatching.

Fire control aide (fire season only).—Handles initial attack on majority of fires occurring within his reach on bad fire danger days. Usually has "hot shot" crew of well-trained men on four-wheel-drive jeep pickup and pumper. Acts as dispatcher on occasion. Capable of handling large fires. Usually first reinforcement when a warden and crew has taken initial action.

Strawboss (fire season only).—Handles some initial attack on low hazard days. Usually reinforcement. Will be capable of handling large fires with additional experience and training.

Primary warden system.—The primary wardens are the backbone of the fire fighting organization. Each warden, who is well-trained and experienced, has a crew of 3 to 10 dependable local men and a truck equipped with fire tools, rations, radio or, in some cases, a portable telephone. These self-contained warden units are used to a large extent for initial attack in their local zones where they are most familiar with the roads and trails, and local conditions. In bad fire situations they are used extensively as reinforcements and so gain experience in other areas.

Many considerations are involved in the organization of a good warden system. The value of a warden depends on his availability when needed, skill at finding and controlling fires, leadership, local acceptance (which is extremely important), need of employment, interest in the fire control job and ability to exert fire prevention influence among his neighbors.

The warden should be properly located as to fire risk and means of communication. He must own or have access to a motor vehicle and must be able to arrange his farm or other work to permit availability for fire work. It is very seldom that a prospective warden meets all the above qualifications. A compromise on one or more points is usually necessary.

The warden organization must be maintained throughout the year. Probably the most important factor in such maintenance is the casual contacts of the year-long personnel with the wardens from time to time. At these frequent contacts a warm personal interest in the warden, outside of fire problems, and a sharing with him of new developments in the Service go far to maintain morale and improve future value of the warden. A 1-day training session is held each year in February, at which time teamwork is stressed as well as individual items of fire prevention and fire control work. At this time a special effort is made to make these men feel that they are a valuable and necessary part of the Forest Service organization.

Every opportunity must be taken to give the warden on-the-job training, and under Clark fire conditions it is not difficult to find such opportunities. It is also possible to give additional training and responsibility to promising wardens so that they will be capable of handling larger problems in the future.

One difficult task is to balance employment of wardens with forest fire fund standby authorizations, problems of risk and danger, and desire of the wardens for employment. The morale of the warden organization hangs on a delicate day-to-day manipulation and balance of these factors. Some wardens want all the employment they can get, while others wish to be called only when absolutely necessary. Limitations of funds holds the number of primary wardens within the number that can be employed to a sufficient extent to maintain their active interest.

The importance of communications with wardens can hardly be overemphasized. Their value in quick fire control depends on prompt communication. Whenever possible, connections are made with Forest Service telephone. Some more important wardens, off the telephone lines, are given radios, and in some cases they must be reached by messenger from the towerman, or by taxi or other means.

In all cases an effort is made to secure some degree of fire prevention by the wardens. The effectiveness in this field varies considerably by individuals. When the warden is a leader in the community we get good returns. In any case the warden must be respected by his neighbors or much damage to the prevention effort becomes evident. As a general rule, the warden has limited value as an enforcement agent. As long as respected neighbors sincerely believe in the value of woods burning, any active participation by the warden in enforcement endangers his value as a prevention and control agent.

Secondary warden system.—The secondary warden may be described as a man strategically located from a fire control standpoint and who is actively interested in keeping the fire out of the woods, but who does not meet the requirements of a primary warden. Lack of communication due to isolated location usually makes the difference. This type of warden is supplied with tools and takes independent control action when a fire occurs in his immediate locality. This type

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of warden has limited value except in rare cases, such as a blow-up situation. His greatest value is probably in the field of local fire prevention.

High school crews.—Two high schools on the district are often called on for fire crews. One of the seniors with leadership ability and experience is set up as a warden and fire crews are arranged through him. One good 10-man crew can be depended on from each school, and an additional 20 men from each in an emergency. Other high schools on the district can furnish untrained crews in emergencies. The high yearly turn-over of trained men from schools limits the value of this source, although this same factor increases the fire prevention potential as these young, trained men become distributed throughout the district.

Industrial crews.—A cooperative agreement is held with the local lead mining company which has extensive land holdings adjacent to the district. This agreement calls for mutual aid. The Forest Service furnishes fire tools and trains key mine foremen. It also spots fires on or adjacent to mine lands and reports them to the company. The mining company agrees to furnish men up to their full complement in case of fires threatening both Forest Service and mine lands.

Cooperators.—This includes a miscellaneous group of people interested in fire prevention and fire control who do not wish to be called for routine fire control activities because of their extensive private interests, but who will respond in a serious situation in any way they can help. These may be ex-Forest Service personnel, business men, or large farmers.

Fire control handbook.—All basic material necessary to the functioning of the fire control organization is maintained in a fire control handbook on the dispatcher's desk. For quick and economical revision all changeable information is recorded in pencil longhand. This basic material is given a major revision just before the spring fire season, and then is revised currently throughout the year as changes occur in the organization.

LET'S CHANGE OUR HEADLIGHT CIRCUIT

ALVA G. NEUNS

California Forest & Range Experiment Station

One thing, they say, leads to another. In this case a search for a throw-away headlight outfit for use on fires led to the discovery that we aren't getting the most for our money out the the present model. In fact, the lamp and battery circuit used by the Forest Service is the least efficient of three tested by C. C. Buck and W. L. Fons at the California Forest and Range Experiment Station.

On the assumption that the current drain on the batteries may be too heavy in the headlight circuit now in use, two other circuits were suggested. All three were set up for comparative measurement. Figure 1 shows diagrammatically the kinds of lamps and batteries used

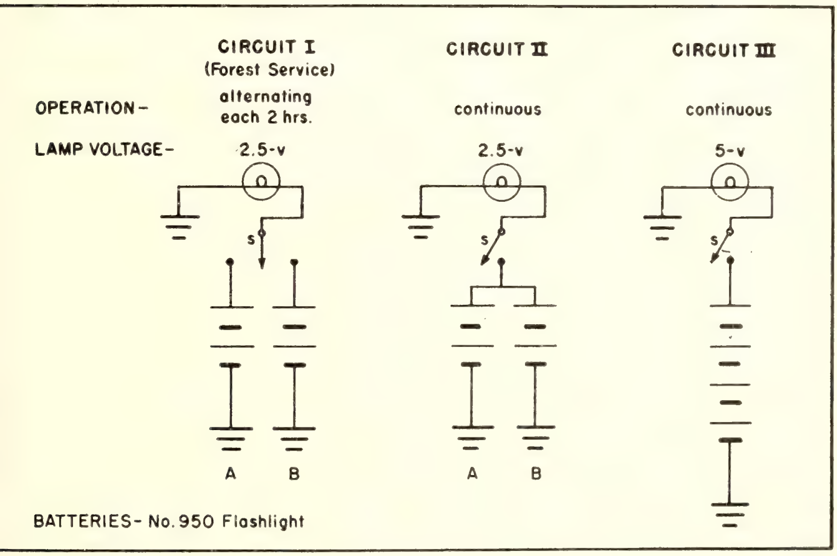


FIGURE 1.—Wiring diagram for three electric headlight circuits.

and the hook-up and operation of the lamp and battery circuits. There are four batteries in each circuit. In circuit I (Forest Service) and circuit II they are arranged in two parallel pairs, A and B. Circuit I draws current from battery pair A or battery pair B. Circuit II draw simultaneously from both pairs and circuit III uses current from all four batteries in series.

An 8-hour period of good light was considered to be a minimum requirement, so the study was set up to cover this period. Circuit I operation is based on the fact that batteries will recuperate if allowed a rest period. Therefore, contact is alternated between battery pair A and B every 2 hours. Circuit II relies on continuous operation of both pairs and circuit III on continuous operation of all four batteries in series.

In order to stabilize fluctuations in light output, usual in bulbs at the beginning of use, each new bulb was allowed to burn 20 minutes prior to measurement. Battery performance was checked by duplicating the observations using the batteries of a different manufacturer. Results were identical in both tests.

Current flow of each circuit during the 8-hour period was measured continuously with a recording milliammeter. Comparative light output of the three bulbs was also measured with a University of California Department of Engineering photoelectric cell photometer for a number of values within the ranges of current flow through the lamps recorded in the individual tests. From both these measurements the light output values were computed for each circuit during the eight hours (fig. 2).

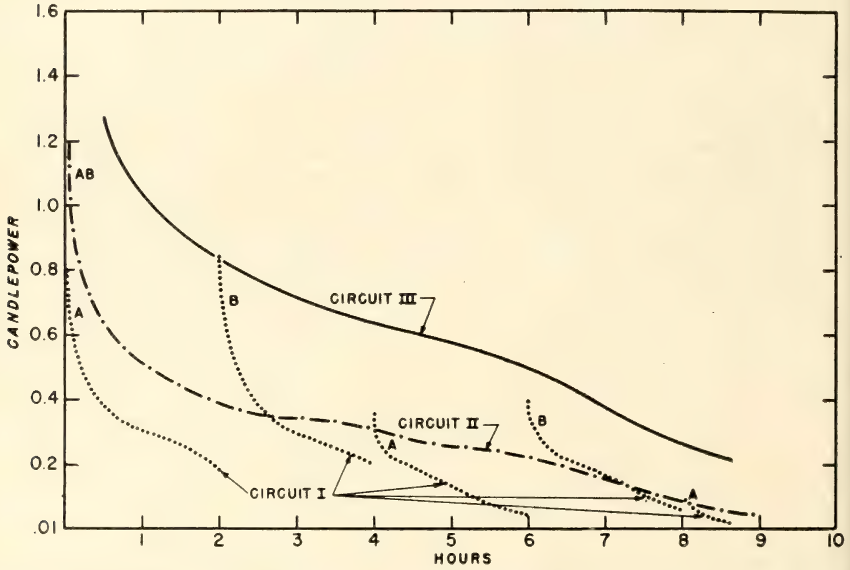


FIGURE 2.—Light output of three electric headlight circuits over an 8-hour period of operation.

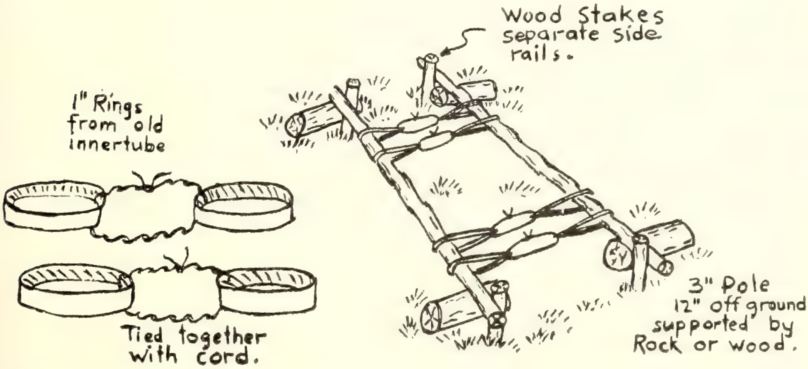
Study of figure 2 will show circuit III to be superior throughout 8 hours of use. At the end of 2 hours it was equal in strength to the initial output of circuit I operating on battery pair A or B; after 3 hours it was still equal to A or B after only 10 minutes use. At no point was it as low as circuit II or circuit I. Note the immediate fall in output and the relatively small recovery after the rest period observable in the alternated pairs of circuit I. Circuit II is a little better than circuit I in that its light output remains more constant. It

loes not fall as low at any hour as circuit I does at the end of each -hour-use period. Both circuits I and II fall off more rapidly than ircuit III.

Besides being least efficient the present Forest Service headlight ıas an added practical disadvantage. The user must remember to witch from one pair of batteries to the other in order to provide them vith occasional rest periods. Ideally, this should result in a usable ight continuously for 8 hours. Actually, this is seldom the case. A nan on a fire or any other job cannot be expected to spend time or hought on how to operate a flashlight.

Even though circuit III is obviously the best of the three, it presents problem in that it uses a 5-volt bulb instead of a 2.5-volt one. This vould require changes in the present headlight assembly. A new eflector has already been designed but expense of cutting the die neessitates the creation of an adequate market before the cost can be ustified and manufacture begun. The same holds true to a lesser xtent for a new throw-away battery case. The throw-away unit vould be ideal for fire use and will eventially be made for that purpose. 'or general use, however, it should pay to develop the new reflector nd modify the present case in order to take advantage of the strong dequate light provided by circuit III during the entire use period.

Portable Bedsprings.—How many foresters and firefighters have laid their ips on a bed of rocks or hard ground night after night in an effort to get a ood night's rest after a tough day? How can this be avoided without too much ost or effort in pruning all the boughs from young thrifty trees? I think I ound the answers in a logging camp visited in northern Maine last summer. This statement is qualified because I have not tried the device.)



Here it is: Cut about a dozen strips an inch or so in width from an old auto nner tube. Hook six on either side of a 6-foot pole. Spread the poles far nough apart for a comfortable width bed, tie the pieces opposite each other ogether with cord, elevate the poles or frame about a foot off the ground and ay bed on top. The illustration gives a pretty good idea of design. Strips nay be placed as close together as necessary, depending on weight of individual.

An alternate suggestion is to use three loops of inner tube, tying together with quare knots, eliminating the string.—Ed Ritter, *Forester, Region 7, U. S. Forest Service.*

SPOT FINDER BOARD AND BINOCULARS ON LAVA BUTTE

E. J. Parker

District Ranger, Deschutes National Forest

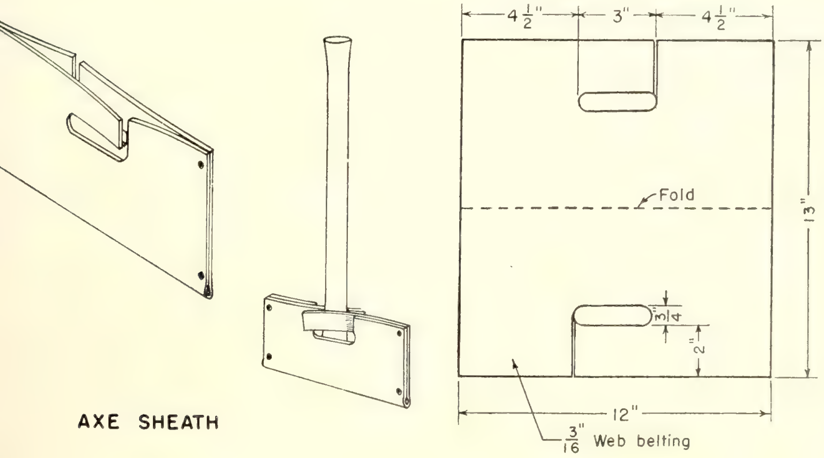
A spot finder board and heavy Japanese binoculars were set up on Lava Butte in 1947 for the use of the public visiting the lookout. The finder board was constructed by tracing the outstanding features from a standard one-half-inch forest map on a piece of plywood that had

Heavy Japanese binoculars on Lava Butte, Deschutes National Forest, Oreg. The spot finder board is mounted off to the left.

een painted silver gray. The summit of the Cascades, peaks, lakes, nd rivers were inscribed in black or dark blue india ink. Holes were rilled in the board for mounting upright pegs over the summit of ach visible peak. The key peg for Lava Butte was painted red, and ie others silver. The air-line distance from Lava Butte and the ele- ation of each peak was inscribed on the map. After the board was riented on the ground and fastened to four vertical pipes, it was ossible for the public to determine the various peaks by simply ooping over and lining up the red peg with any one of the silver egs. Though no lakes were visible from Lava Butte, their location 1 reference to the outstanding peaks was of interest. Instructions or use were printed in one corner of the board. The board was rotected by giving it two coats of spar varnish before mounting.

The mount for the heavy Japanese binoculars was constructed by Ir. Westcoatt of the Departmental Shop. The binoculars were hung y means of a vertical tilt spring and friction bolt and the assembly ivoted on a threadless pipe cap. The public seems to enjoy using iese fine glasses, and 10,000 people annually make Lava Butte one f the most visited lookouts in the Pacific Northwest Region.

Inexpensive Ax Sheath.—Ax sheaths or other protectors for ax blades have ng been recognized as essential from both a safety standpoint and to protect ie blade. The loss of sheaths on going fires is unusually high and in recent ears the cost of replacement excessive. In an effort to solve the problem at inimum cost, Ranger Cleo J. Anderson began experimenting with different aterials and methods. The best solution seemed a sheath of scrap webbing ⅜ ich thick. This was split to give a better thickness to work. The $\frac{3}{16}$-inch ebbing is still more durable than leather and only slightly heavier. The ma- erial is cut to a pattern with grooves to fit over handle and joined by two rivets 1 each end. Straps, buckles, and carrying ring can be added if desired.— ERL CHARLES, *Assistant Supervisor, Tonto National Forest, Ariz.*



THE MOUNTING DOUGLAS-FIR SLASH PROBLEM IN WESTERN OREGON AND WASHINGTON—WHAT CAN WE DO ABOUT IT?

Kermit W. Linstedt

Chief of Fire Control, Region 6, U. S. Forest Service

Currently there are about 25,000 acres of national-forest lands being cut over in western Oregon and Washington each year.

When areas on which disposal by broadcast burning is not planned have been set aside and we add those planned for burning but not burned, we find that areas of unburned slash are developing at the rate of some 10,000 acres a year.

I presume the experience on national-forest lands to be little different from that on State and private lands. A problem of what to do to meet this increasing hazard becomes evident.

There are several approaches to the solution of the problem. Probably the best long-time solution lies in closer utilization. The production of plastics, alcohol, fiber board, and other comparatively new developments gives promise in assisting with the problem in a manner that certainly should not be overlooked. To the practical man who is confronted with the problem as it is today, these possibilities, which will undoubtedly be developed by science to a continuing degree, are only something in the dream stage and are not at all a solution of the immediate problem.

In Rhode Island the Soil Conservation Service has made a trial in grinding up the woods waste resulting from logging and putting it back as litter on the forest floor to enrich the soil. This is a commendable start, but like the utilization suggestion, it has not developed to the point where it offers any real solution of the slash problem at the moment.

Another approach to the problem is to leave the slash on the ground to decay by natural means and give it an additional standard of protection in that interim. This complements the first suggestion in that it permits salvage of some of the material for a good number of years after the original logging.

Experience in protecting slash areas on the ponderosa pine type adds promise to this proposal as a means of hazard abatement. Undoubtedly, there are areas and situations in the Douglas-fir region where the same is true. In all too many cases, however, accumulated slashings in western Oregon and Washington have set the stage for disastrous fires. Even with good additional protection, there exists considerable question as to whether it is reasonable to expect that we can protect these areas from fire for the time necessary to abate the hazard normally.

Under present economic conditions the major approach to the slash roblem then lies in the much-debated practice of burning.

Successful disposal of slash by burning calls for complete consider- tion of the problem from the time the first work is done toward laying ut the logging plan until the disposal fire is extinguished.

For best success in slash disposal, more effort must be expended in pplying known techniques of fire fighting to this all important job. 'he same basic principles hold good whether they are used to suppress wild fire or to purposely burn an accumulation of logging waste.

Many of our problems in burning slash have stemmed from a failure recognize this clean-up after the harvest as a legitimate cost of peration chargeable to logging.

We must start with a recognition of the job to be done and the eed for doing it. From there on, it becomes a matter of planning, dequate financing, and the application of the best-known techniques the accomplishment of the job.

The staggered-setting system of cutting has probably done more ian any single recent development to aid us in the solution of the iounting slash problem. This system allows a better selection of me to burn because of the limited acreage to be burned in any one nit.

In this system of cutting as in any other, strong emphasis should e placed on planning the slash disposal at the time the first cutting rea is considered. There are a number of important considerations iat follow on through the cutting operation and until the time of ctual disposal. I will review briefly the most important of these.

1. The cutting unit should be established on the ground so that full dvantage is taken of all natural topographic breaks. It is particu- ırly important to have a topographic break at the top of a cutting nit. Minor ridges can frequently be used to form the sides of cutting nits.
2. Roads can frequently be so located as to form a break at the top f the cutting area which has no natural topographic break.
3. The cutting area should be kept to a maximum of 40 to 50 acres ı size if practicable.
4. All trees possible should be felled into the cutting area.
5. All trees and snags within the cutting area should be felled.
6. All dangerous snags should be removed for a distance of 200 eet around the exterior boundaries of the cutting area.
7. Fires should be set in a drying-out period after a rain.
8. The best possible weather information should be obtained prior burning. This applies especially to winds and east winds in articular.
9. Adequate manpower should be on hand to set the fires and insure ontrol.
10. Slopes should be burned from the top down. Level areas should e fired first on the inside and then around the edges of the cutting rea.
11. When the decision has been made to burn, burning should be ccomplished in the shortest possible time. Mop-up of the fire edges hould be started as soon as the burning of fine fuels has been ccomplished.

In conclusion, it is my opinion that we must first do all we can in utilizing what is now waste material in the woods. Secondly, when better means are not available, we must aggressively plan and execute disposal by burning most of our slash currently if we are to avoid catastrophe and accomplish the best possible management of our forest lands. We must recognize, of course, that the effect of burning on site, watersheds, and similar factors must be considered and disposal of slash through burning adjusted to meet the primary needs of these factors.

Blazing the Road to a Fire.—The first attacking crew enroute to a fire does not always find it practicable to stop and erect signs indicating the proper road to that fire. If there are numerous roads the job actually becomes time consuming. The signs placed in a hurry often blow over or get knocked down. They are difficult to see and in some cases give wrong information.

During the fire season of 1949, the following method was employed on the Saugus District of the Angeles National Forest and found to be very practical.

About a quart of flour was placed in a paper bag. The opening of the bag was folded down and taped shut. About six of these bags were placed in an easy to get to location in each fire-going vehicle on the district.

At each road fork where there might be a question as to which road to take to the fire, the flour in these bags was used to indicate the correct one. A crewman merely broke one of the flour bags, got out of the truck, and walked along side the tanker as it went through the intersection. In this manner a line of white flour about 10 feet long was deposited on the road indicating the direction traveled by the tanker. Equipment following can easily spot this white line and take the direction indicated.

It is not intended that this method wholly replace the "Fire Camp" sign, as the flour streak becomes obliterated in a short while if there is much traffic. If the fire lasts any time at all regular signs should be erected.

The main advantage of this system over the signing method is that it gets done. Members of a suppression crew seem to be anxious to leave this mark. It has an appeal that the signs seem to lack. Other advantages are that it is quickly done and much easier to see than a sign.—CHARLES T. SMITH, *Suppression Crew Foreman, Angeles National Forest.*

LIGHT DUTY POLE DOLLY

KEITH C. EULER

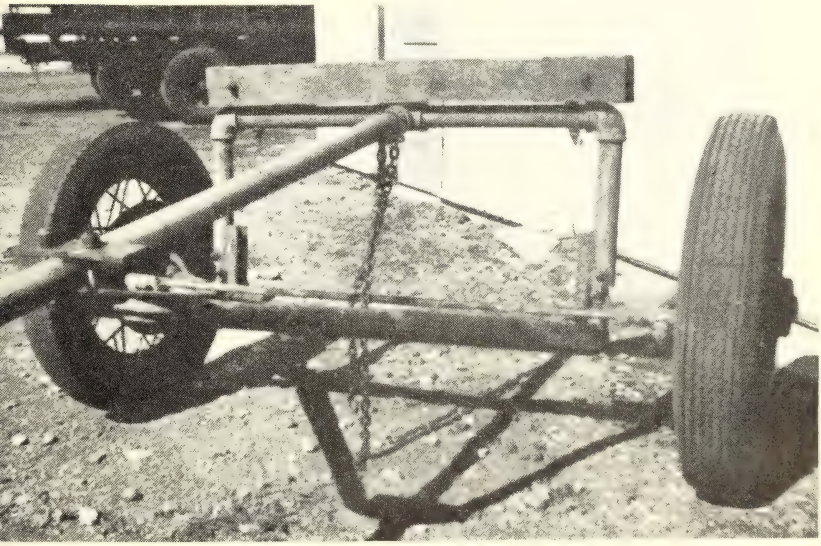
Engineering Aide, Modoc National Forest

Too often stake-side trucks have been uneconomically used to dis-ribute one to three telephone poles on minor telephone line repair bs. This has been overcome by constructing a light duty pole dolly r use behind a pickup.

The light duty pole dolly was constructed locally from a Ford front xle and wheel assembly and a few pieces of salvaged 1½-inch water ipe and fittings. The total cost of materials was less than $50. With is unit, the butts of up to six poles may be placed in the bed of a ickup and the dolly, fastened to a standard hitch, carries the re-ainder of the load.

The use of this dolly has not only made the job easier but has cut e transportation cost in half.

Details of construction are shown in the photograph.



DEATH ON THE FIRE LINE

Seth Jackson

Administrative Officer, U. S. Forest Service, Washington, D. C.

A review of fire fatalities through the years focuses our attention on four major problems.

The greatest man-killer, of course, is the blow-up fire which almost yearly takes its toll. Hundreds have died from this source, if one considers the historic fires of the past, such as Peshtigo. Losses of life are becoming fewer because of organized fire-suppression efforts. Fast initial action with machine-age equipment such as planes, trucks, and tractors, a better understanding of fire behavior, more thorough planning of control strategy, more foremen trained in handling men on fires, has had much to do with the reduction in the number of fire fatalities in recent years. But blow-up fires still constitute the worst potential killer. Much yet remains to be done before the problem is solved.

The second major problem is closely related to my first point. Under extreme emergency conditions, such as occur during blow-up fires, oftentimes men fail to carry out instructions. In trying to work out their own salvation, they become trapped. To overcome this, stressing of crew discipline is a must!

Training to foresee potential events will help. Instructions can then be given before it is necessary to think under pressure. A top foreman gives clear, concise instructions. He tells and demonstrates to his men. He stresses the need of following orders. He checks his men by direct questioning to be sure they understand. He knows them by name; gains their confidence. He follows up to assure compliance. He emphasizes obedience. If and when an emergency comes, he will then be able to control his men and guide them to a previously selected safe location, thus avoiding the crisis.

The third problem crops up almost yearly. Often during fire emergencies, large numbers of men are recruited in a hurry. In the stress of filling the orders for manpower frequently not enough thought is given to their physical condition for the arduous duties ahead. This puts on the fire lines physical incompetents who are actually detrimental to fire suppression. They do not pay their way. They are a drag on the entire organization. All too often, one of these men dies from overexertion.

The remedy is careful screening at the point of hire and again during transportation to the job, in fire camp, and on the fire line itself. The more obvious misfits can be easily screened during the first contact. They may not be properly clothed or shod. They might be in obviously poor physical condition. Direct questioning about such things as hernia, heart, lung trouble, or previous debilitating injuries will

weed out many. This process should continue right on out to the line, where in spite of the best intentions, an occasional misfit will arrive.

The fourth problem, tree felling, is common to all forestry or construction work. Last year it was highlighted in fire suppression when four men were killed on national-forest fires alone. Tree felling is a dangerous, unpredictable business. Trees fall or are blown in unexpected directions so often that this possibility should not be overlooked during the best conditions. Wearing hard hats is one safeguard which could well be applied more universally. In addition, it will pay even the most experienced woodsman to plan ahead for the unexpected occurrence. Tricky air currents on fires, and rotten snags with dropping branches or more or less holding wood than anticipated, can cause misfortunes in a few seconds. Injuries can come from lack of a planned escape route, too many men working within the radius of fall of a tree, or simple carelessness.

Probably the thing which is needed most of all in tree felling is lumberjack training which stresses key safety points at each step in the operation.

Looking into the future, we can expect continuing serious injuries and fatalities, accidents from trucks and tractors and mechanical line builders, injuries from plane or helicopter use. Here again, careful training in the use of such equipment and in how to spot hazards will help reduce the number of injuries and fatalities.

At best, fire fighting is hazardous. But it is a job which must be done. We do not want to develop the feeling that because fires are dangerous, we should back away from them without good reason. We must, however, respect the aggravated hazards in fire control and do our best to control them. At the same time, we can instill confidence in our men by letting them know that their welfare is our first consideration when laying out our fire-suppression plans.

WARNING SIGNS FOR FIRE FIGHTERS

A. A. Brown

Chief, Division of Fire Research, U. S. Forest Service

In 1949, 32 men died as a direct result of forest fires on national-forest, State, and private lands. Most of them lost their lives because of extreme fire conditions which resulted in blow-ups. These comments will be confined to these special situations.

Probably it is expecting too much to make fire behavior experts of all fire bosses. Nevertheless, we should go as far as we can in the interest of safety and sound fire strategy.

We need to study the large fire from the point of view of a local weather phenomenon. As soon as sufficient heat and sufficient area, from which heat is rising, have crossed a particular threshold, the fire takes on new potentials in behavior beyond those to be expected by simply extending the dimensions of a small fire. Sometimes we say "it begins to write its own ticket." This is because of the air turbulence which is set up. Similarly, there is good evidence that local atmospheric conditions, beyond the already known effects of humidity and wind, play a big part. This relates to the stability of the air at the location of a fire. It seems reasonable, when an existing atmospheric inversion or ceiling gives way under pressure of a mass of hot air and gases from below, that there is a sudden acceleration in both the rising and descending air currents and a corresponding acceleration in the surface air circulation with effects similar to those of blowing fresh oxygen on a smoldering fire.

In other situations unburned gases seem to accumulate, then explode.

Full analysis of such factors will require the help of competent meteorologists and active participation and close cooperation by both research and administrative groups. This will be essential if we are to make significant new progress in foreseeing blow-up behavior. It can be done.

In the meantime, here are some warning signs to consider when critical situations arise:

Manpower placement and safety

1. Every fire crew boss needs to have a good knowledge of fire behavior if he is to be left on his own responsibility. The alternative is close supervision and explicit safety instructions by an experienced supervising officer.

2. There is always danger in placing men above a large fire and in fighting it from the head down in steep country. Wherever such strategy is necessary, lines of retreat and places of refuge become a critical part of the responsibility of the fire boss.

3. Closely related to No. 2 is the fact that it is always hazardous to attempt to outrun a fire uphill when there is danger of being

rapped. Nearly always there are safer alternatives.

4. Special precautions are needed in assigning men to special duties vhen they are detached from the main crews or will otherwise be solated for a time from direct supervision and guidance by an exerienced fireman.

5. The danger of being asphyxiated is often overlooked in selecting laces of refuge. The bottom of a gulch in the direction of spread nay become a chimney flue even though it has no fuel to burn, and nost low places directly in the path of the head of the fire have uch hazards.

ffects of ground cover

The fire front moves much more rapidly through grass and open over than through heavy timber. All experienced fire fighters realize his but they often underestimate the contrast in the rate of spread. he fire perimeter can be expected to change from 2 to 10 times as apidly on the sectors of a fire in that kind of cover. These two—heatgrass and dry bunchgrass—have extremely high rates of speed n steep country, even if the cover is sparse. It is well to recheck he known ratios between contrasting but intermingled fuel types nd to impress them on trainees.

nfluence of weather and topography

1. Prevailing wind direction, particularly if the wind is of low elocity, will be modified a great deal by rugged topography.

2. Extremely rugged country is apt to produce erratic behavior in ny fire that has gained momentum because of the conflicting air urrents that are set up.

3. The mouth of a canyon in rough country is always affected by onflicting air currents. Any fire in its close vicinity is likely to eflect these air currents in its behavior. The head of the fire in such ases may not be the most threatening.

4. To an experienced fire fighter, dust devils—those local whirlwinds f dust—are an ominous sign. Such whirls account for many low-ups.

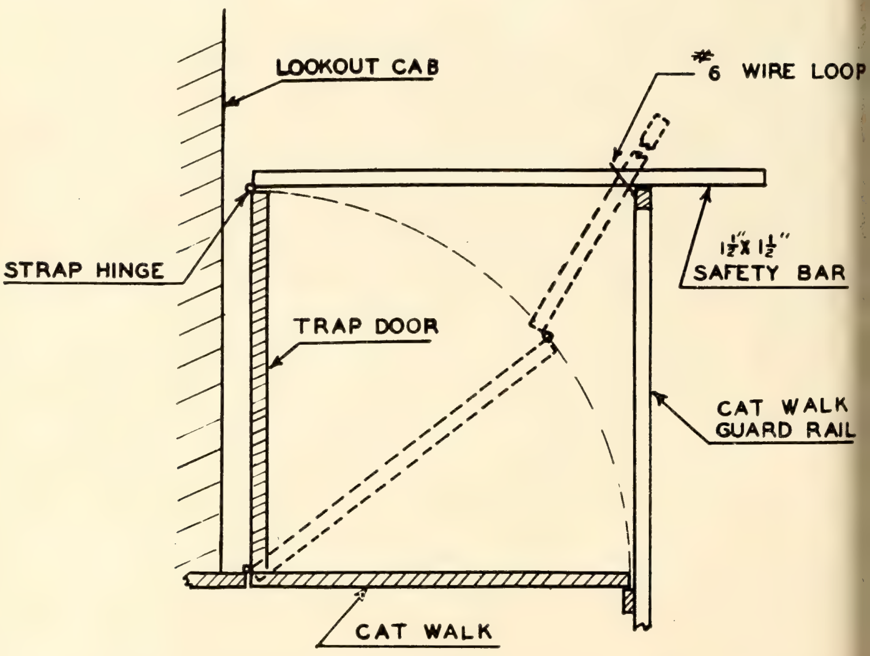
CATWALK SAFETY BAR

H. E. Branagh

District Ranger, Los Padres National Forest

Many of the lookout tower trap doors in California are equipped with safety bars that the lookout man can only hook in place by walking all the way around the catwalk from where the stairs enter it. For that reason, lookout men are prone not to bother putting the safety bar in place when the trap door is open.

The drawing illustrates how a simple, yet effective, automatic safety bar operates. When the door is closed, the piece of lumber 1½ by 1½ by 40 inches, is out of the way by being adjacent to the guardrail. In this position it protrudes 4 inches above the top of the railing, and is held in place by a loop of No. 6 galvanized wire which is bolted to the angle-iron railing.



The lower end of the safety bar is connected to the outer edge of the trap door, and is held in place by means of a strap hinge 1½ inches in width.

Installation of this simple device is positive assurance that the safety bars on lookout towers will always be in their proper place when the trap door is open.

HIGH LIGHTS OF FIRE CONTROL EQUIPMENT DEVELOPMENT PROGRESS IN REGION 1 [1]

Division of Fire Control

U. S. Forest Service, Washington, D. C.

REGION 1 FIRE LINE TRENCHER

A trial model incorporating information gained from earlier experi-ents was completed during the winter of 1948–49. This was given a irly complete test during the spring of 1949. Objectives governing e present project and results obtained from previous pilot model are follows:

1. Size and weight should be suitable for aerial delivery. The test odel weighs 175 pounds and may be packed for aerial delivery in a box oproximately 20 by 24 by 36 inches.

2. Units should be self-propelled for ease of operation and to reduce anpower required for suppression use. The test model is powered by horsepower, 4-cycle, air-cooled motor. The arrangement of power ive is such that the machine is powered both forward and reverse rough a quick-acting clutch.

3. Performance should be such that a substantial saving in line oduction may be accomplished. The previous test model has not en used enough to obtain performance in all types of ground condi-ons. In open types of slope 0 to 30 percent and little or no rock, the achine built 19 chains of acceptable trench in a 15-minute run or 76 ains per working hour. On the most difficult area tried with side ope up to 70 percent and with considerable heavy rock, the trencher ilt 8 chains of trench in a 15-minute run or 32 chains per working ur. This is about the limit of operation and is very tiring for erator working the machine alone.

4. Climbing ability should be such that the machine will trench up opes of 60 percent where ground conditions are suitable. The test achine has built trench up a 50 percent slope. In this test there was rock but considerable light brush. Short runs have been made up percent slope.

5. The machine should operate on steep slide slope. This indicated at the limit for side hill operation is around 70 percent. For the 1950 cal year the following was planned: (a) Make final design for pro-uction; (b) prepare specifications and shop drawings for production three units; (c) construct three test units for field service and break-own testing.

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[1] Extracted from reports to the Chief, U. S. Forest Service.

Progress through January 1.—Drawings are nearly complete and any questionable mechanical application not used in the first model has been tested on a wooden mock-up. Detail drawings of frame, drive arrangement, and handle control have been analyzed for strength by outside engineers. The frame has been shown to a manufacturer for refinement to permit accurate fabrication. Construction of several items such as sprockets and wheels has already been done. It is expected that the three units will be completed in May, and the tests completed in June 1950.

PARACHUTE TEST INSTRUMENT

Since costs prohibit the use of instruments developed by the military an attempt is being made to develop simple low cost instruments for this purpose. To date one instrument has been constructed which appears to have some promise for recording opening and landing shocks. Calibrations have been made with good results. The instruments consist of two large cylinders with pistons having approximately 10 square inches surface. Air from these cylinders is forced into a small one of approximately 1 square inch area. The piston in the small cylinder acts upon a spring which controls the length of line on the recorder measuring opening and landing shock. The test instrument may be weighted for various types of parachute to give load from 50 to 200 pounds.

AIR-CUSHIONED CARGO CONTAINERS

This container is constructed for aerial delivery of miscellaneous cargo. It contains an air chamber to absorb landing shock. Cargo is placed inside a cardboard carton of standard size which is in turn placed in a box. The inner container is allowed to slide inside the box but is cushioned by the air which must escape past the cardboard carton or through escape holes.

LONG-TAILED PARACHUTE

A long-tailed parachute is essentially a standard chute, except that the loading is attached to the chute with a rope approximately 75 feet long. Test drops have indicated near perfect operation in tall timber and the long line has always let the load down to the ground very easily. The chute acts as a brake as the cargo drops to the ground between the trees. Tests indicate that it is much easier to retrieve the chute—many of them without climbing or felling the trees. Too many failures due to breaking the long rope have shown the need for nylon or other high-strength rope. Tests with new high-strength rope should bring successful completion of this item.

PLATFORM FOR DISCHARGING HEAVY CARGO

In order to speed up dropping operations and save flying costs when large planes are used in cargo dropping, an aluminum platform with ball bearing rollers for discharging heavy or bulky cargo or for dumping several small bundles simultaneously is being devel-

ped. The present arrangement locks the rollers against the floor of he aircraft while cargo is placed on the ramp. When ready for dis-harging bundles over the dropping spot, the rear of the platform is aised to free the rollers and slide the cargo out the door. The pilot nodel is being constructed for use in a C–47 airplane. No tests have een conducted on this item.

FIRE MESS OUTFITS

Changes by manufacturers and developments during World War II ave made many items in Forest Service mess outfits obsolete. The 950 fiscal year project includes:

1. Canvass regions for ideas and suggestions and for information egarding types and sizes of fire mess outfits needed.
2. Develop new methods of packaging suitable for all types of arriers. Investigate new types of lightweight plywood containers.
3. Explore fully paper or other disposable products or other new naterial which may be suitable.
4. Analyze contents of mess outfits and bring up to date.

Progress to date.—Questionnaires completed by regions have been eceived and are being analyzed. Information upon available equip-nent is being catalogued and many samples are being tested and com-ared. Several sample outfits will be made up for experimental use uring the summer of 1950.

Disposable Headlights.—Because of the claim of several western regions that eadlight losses on large fires were quite high, it appeared desirable to investi-ate the possibility of developing an expendable headlight that could be pro-uced at a very low cost. Region 4, United States Forest Service, made up an xperimental unit as follows:

The lamp used was of the fixed focus penlite type globe which eliminates the ecessity for both a reflector and glass cover. The lamp socket and headpiece ssembly was made from tin-plate material with a rubber pad clipped on in a milar manner to that used on the standard Forest Service headlight. A light iece of metal was used to support the socket and to project from the headpiece, llowing for adjusting the angle of the light by simply bending this arm to the ngle desired. The head strap was taken from the Forest Service standard eadlight. The wire used to make cord was a multistrand plastic covered wire hich is soft and pliable. One end of this cord was soldered to the lamp socket, ne other end has a two-pronged plug. The battery pack was made of two rdinary flashlight cells connected together in series by piece of wire and rapped in paper or tape to form a two-cell pack with a socket for two-pronged lug. The connection was made by simply inserting the two-pronged plug into ne battery pack socket, thus eliminating the cost of a switch.

This experimental headlight gave a satisfactory light. The total estimated ost of all parts used is approximately $1.54, including one battery pack or $1.24 ithout battery. A simple economic study made by Region 4 shows that if xpendable headlights at $1.24 each were adopted, the annual cost to the Region ould be approximately $1,200 more than the present cost with the standard orest Service light. From this it appears that the cost of the disposable type eadlight cannot be more than 60 cents each, if they are to pay their way.

The results of this project show that without a radically new design there is ttle hope of obtaining a disposable headlight cheap enough to compete with the resent Forest Service standard unit. Therefore, our next step should be toward nproving and reducing the cost of the standard headlight.—Division of Fire Con-rol, *U. S. Forest Service, Washington, D. C.*

LETTER TO A PROFESSOR IN FOREST PROTECTION

[This excellent letter was written in December 1949 by Arthur W. Hartman, assistant regional forester, Division of Fire Control, Region 8, in response to a request from a Professor at a midwestern university who was preparing a course in fire control. Headings have been inserted for the convenience of the reader.—Ed.]

"* * * Forest management in all its phases is a developing, progressive matter. Professional foresters, and the teaching of them, dare not be static. One located at a vantage point for observations must conclude that generally speaking, portions of university training are outdated. Too often new graduates come to work indoctrinated with about the same ideas as were given to me some 35 years ago and which have been passed along with little adjustment to the revelations of experience. * * *

"Fire control is still seen by many at a level of vocational performance or craftsmanship. Our profession is relatively young. So much so that thinking has not emerged generally to where the different levels are defined. For illustration purposes we shall borrow from older professions:

"In construction work we all are familiar with the differences between an architect and the pipe fitter, stone mason and carpenter, and the different levels of training, viewpoints, and thinking each must follow. We are familiar with the variations between a mechanic and a mechanical engineer, the builders of power lines and the electrical engineer. * * *

"A good mechanical engineer should in his early days be given a vocational ground work. He should learn the feel and use of tools, acquire some personal skill in the shaping of metals and gain a working knowledge of shop practices. Thereafter, he moves to the fields of intensive design and applied engineering.

"Any professional forester, if he is going to progress to where he can successfully meet responsibilities for developing and protecting a major high value forest property, must sooner or later learn to see things and think along the same lines as an industrial engineer. As a student, this fact of life should be made plain to him.

"If you will check back over your own school days, field training camps you have attended, and much of the protection literature, I am sure you will find that a pretty good job was done in making you familiar with the working tools. You learned of the tools of fire detection; towers and lookout men; communications and reporting; transportation; project fire camps, how to equip them and feed the help. You no doubt swung a Pulaski tool and built fire lines to acceptable specifications; actually felled dangerous snags, gained an idea of shop practices. * * * At that point one must be classified as learning

a trade, developing into a pretty good skilled laborer, or a competent foreman of labor, something of a technician.

"It is above that level where stress and development is needed if young professionals are to gain a concept and understanding of a professional approach to the protection of our timberland resources from fire. Rather than thinking of each function or subject as a thing by itself, good fire control engineering requires an evaluation and blending of economics, silviculture, human relations, laws of nature, logic, soils, and related sciences.

"Proper evaluations, anticipating probable changes, transitions, or events, and planning to be ready to meet most of such things before they are on you—by these, and the quality of their application, is determined whether the battle is won or lost. Of course, no one can be brought to that stage in the classroom. Much experience and many hard knocks are required before the individual comes to a realization of the meaning, value, and place of the many things he is taught.

"Were I to attempt to teach fire control, I think I would first start at the top, give them a professional goal or objective to work toward, outline the finished structure, then of the component members, their places and functions in the whole. Later, as they are led through the subject of working tools and shop practices, as they come up through silviculture, economics or other of the courses, students would be better able to relate them and see them in perspective.

"Certainly they would not be misled into believing that fire control was a matter of just finding fires and extinguishing them. They would gain an understanding that fire is to forestry as diseases are to the human frame. The competence of the medical examiner and diagnostician, the skill of the surgeon or doctor in treatments, eliminates, limits or greatly extends the usefulness of persons. You already know that however ideal the theories of resource management and however good the plans, the results are very much at the mercy of the degree of protection attained.

PRESCRIBED BURNING

"It is good to learn that you are going to give the students an insight into the usable qualities of fire. The woods are full of inhibited men. Southern foresters are more and more adopting the wholesome and, shall we say, scientific approach, segregating facts for what they are and laying them out in the open for nonemotional assessment.

"Unfortunately, you have cited the available literature on prescribed burning. Yes, the use of fire has spread greatly across the South. Quite a few things have been learned or refined. Perhaps it is not as yet timely, but for one reason or another the subject has not been brought up to date in print.

"The Region 8 national forest prescribed burning program for the coming winter will encompass about 200,000 acres. That will include some 25,000 acres of loblolly located both on the Francis Marion in South Carolina and in Texas. The region for a few years had more critical longleaf burning to do than could be handled financially. Loblolly burning was carried on experimentally but on administrative sized blocks. * * *

"Several State forestry organizations have trained their district men to where they now give technical advice to landowners on whether or not to burn and how to burn. Some of the major industrial landowners are using fire when and as they believe such operations are called for.

"Following are some of the things you may not find in print:

"People are like pendulums—they tend to swing from one extreme to the other. One finds the pure fire exclusionist; after learning just enough to know fire can produce some marked benefits (but not enough to appreciate its complexities), this type tends to swing too far over, get 'match happy' and overdo it. That is why students should be let in on the facts and become ingrained with the idea that to burn or not to burn is a matter of cold-blooded analysis and calculation.

"We are not burning in the upland or Piedmont topographic types. We know pretty well the direct physical effects of fire on the various commercial tree species and on the low-grade brush which is encroaching. What the profession has yet to determine are: measures of fire effects on biological content of soils; on water absorbing qualities of soils; and definition of that zone when pine, hardwoods, and brush species are in satisfactory balance.

"Foresters in position to observe wild fire and its effects on loblolly have known for many years that the backing portion of a fire produced no important damage among 4-inch diameter and larger trees at certain seasons and when soils are moist. That observation is being well confirmed by large-scale tests.

"A fairly widespread concept has been that prescribed burning is a form of 'light' burning, done to keep an area from being burned by wildfire. Such a primary use of fire is rare and occurs mainly for the purpose of breaking up or partially insulating major areas having lethal fuel accumulations.

"Most fire use is primarily for silvicultural effects, and on a given area will be accompanied by a considerable spread of years between burns.

"Seedbed preparation and brown-spot control burning have secondary effects of reducing fuel and keeping shrub species controllable.

"Slash and loblolly pine areas in the South have been undergoing a major transition during the last decade. As protection progressed and wildfire burning became less frequent, the various understory species have taken ascendancy over commercial species. Where there have been no fires, such a dense ground cover has developed that reproduction cannot succeed. If that situation is not treated, rather than practicing sustained yield, it will be a matter of gradually harvesting the established stems, then presenting to the public extensive brush fields as the product of professional management.

"Industrial foresters in such areas are plenty scared. They hired out to produce a sustained flow of raw materials for the mills. Cold-eyed directors are beginning to look around and ask questions as to the whereabouts of the future crop. It is a problem that has to be solved, and solved on a business-dollar basis, if the profession is to maintain claims of being expert timberland managers.

"Fire is not the only tool that can be used toward modifying the war between pine and brush for control of an area. One can use bull-

ozers, poisons, or an ax. In areas of lush growth, the present day sts of such treatments are economically prohibitive. Fire treatents can be effected at around 20 cents per acre.

"This same problem—what species will dominate—is present all e way across this region, and it is gaining momentum. A forestry aduate who goes to this or similar areas, can, if warned of conditions id trained to view the problem with an open mind, be in line to figure t successful performance. The others will be handicapped and less tractive buys to a business wanting results. * * *

RATE OF SPREAD

"There are two types of rate of spread: One deals with increases fire perimeter; it reflects the size of the line-building job. The her is the rate at which the head or heads of fires travel. It reflects e strategy to be employed to head off the fire. * * * As wind locity increases, spread rate increases more than proportionately ie to spotting well ahead of the flames.

"Because of terrain, or for lack of proper equipment, it is necessary suppress many fires with manpower. That method is costly, both direct cash outlay and in producing larger burns on the average th higher fire damage.

FIRE LINE EQUIPMENT

"Various types of motorized fire line equipment have been developed d the spread of their use is rapid. Tractor-plows, bulldozers, motor hicles with plows, etc. When properly designed for terrain, soil d cover, and used by experienced men, such units can build more and tter fire line in an hour than can 25 men. Because a tractor does t tire as a line worker will, their relative advantage over men ineases as time passes. A given fire is handled at a lesser over-all cost d the burned acreage is considerably less.

"Students should become aware of powered equipment suppression tentials and be given sufficient insight to realize that present-day velopments are only milestones, that they are the ones who will ve to devise and adapt to their advantage even better equipment industrial advances make opportune. * * *

HUMAN RELATIONS

"It would be difficult to overstress to forestry students the decisivess of human relations over their future success. They may gradue highly polished on scientific theories and facts, but it will be the ectiveness with which they apply and operate them that will be e measure of their value. Important generally, but they should preciate that in fire control human relations exert at least half of e total influence on results.

"For most timber growing areas the fire problem (both prevention d control) is pretty much a human problem. It is tied into the derstanding, thinking, actions, and reactions of great numbers of ople from all walks of life, with varied degrees of education, and th different backgrounds and traditions. People cannot be treated

as a mass. Properly influencing them will require development o the desire and ability to make penetrating and understanding analysi of them. The forester will have to live among them and work wit them. A crucial necessity is that he first succeed in selling himsel to a point where he can break through firmly established barriers o clannishness, provincialism, and some prejudice. Only then will h gradually become accepted. Many a young forester seems unawar that he is constantly under observant eyes that measure and weig his every act. Once he is weighed, for good or bad, people fix an freeze his level of prestige and leadership among them.

"It is more what some might call the little things that count: th sincerity and workmanlike manner with which he goes about eac task; the interest in and little considerations he gives to the ordinar fellow he encounters; the willingness to go to a little extra effor to be helpful; retaining his proper position but still being warm an friendly.

"I have seen quite a lot of young foresters make their starts, observed their accomplishments, and noted the influence of variou factors over their progress. Far too many have limited their usefulness or broken their careers because of a lack of appreciation an sensitivity to the human side of their jobs. * * *"

/olume 11 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

"GRASS ROOTS" FIRE PREVENTION

HENRY SIPE

Assistant Supervisor, Cumberland National Forest

'he annual fire statistical report indicated the number of forest s in the United States increased 11 percent in 1949. Census fig- s for 1950 will likely show the country's population to be growing ut 2 million each year. This adds up to an increased fire risk. hough some of the increase is in unprotected areas, debris burning s on protected areas, for example, increased 48 percent and incendi- fires 33 percent.

'ires can be prevented in two ways: "Shotgun" methods such as the rent CFFP campaign posters, news mats, booklets, bookmarks, elope stickers, etc., or "grass roots on the ground" work by forest cials. There may be those who feel that law enforcement is the l answer to the fire prevention problem; I do not. The following mple may illustrate some basic philosophy in fire prevention.

'he Sand Hill fire control unit of the Cumberland National Forest 1946 had an alarming increase in the number of fires. This trend tinued in 1947 and 1948, and measures were required to combat the blem. The unit contains 12,400 acres. There are about 110 fam- s scattered fairly well throughout the unit, mostly on submarginal ms. Man-caused fires, excluding railroad fires, that occurred in unit are as follows:

	Number of fires		
	1946	*1947*	*1948*
se:			
Smokers	4	3	3
Campfire	1	0	0
Debris burning	0	1	1
Incendiary	0	1	0
Miscellaneous	5	1	3
Total	10	6	7
s per 10,000 acres protected	8. 1	4. 8	5. 6

ce the Cumberland National Forest objective is not more than 0.8 per 10,000 acres protected, the occurrence rate was 6 to 10 times high.

Although only one fire is classed as incendiary, probably more uld have been. At least one family was suspected of setting job s. Another had careless children who might have been causing s.

In recent years the ranger and his yearlong helpers had not traveled ough the area sufficiently to get acquainted with the people. The kout assigned to the fire tower in the unit was well known, but had etiring personality and was not in good health.

It was decided to visit as many families and schools as could b reached in 4 days early in 1949. The area had no good roads, so a jee was used. In February, in company with either the district ranger, forest guard, or the lookout, I visited 65 families and 4 one-roo schools. At the schools we showed colored slides, using the jeep ca battery for power. Kodachrome pictures of the pupils were take A contact list was made, and keyed by number to a contact map.

On March 18, 1949, a friendly follow-up letter was written to som 70 families in the area and to the school teachers. The letter describe why the area was chiefly valuable for timber and gave the growth ra of timber, its financial value, and how the woods could be made t produce good crops of timber. Fire prevention was listed as the fir step. The letter closed with a promise of more letters to follow dealin with improvement of the forest.

During the fall of 1949 a similar contact trip was made. A ne ranger participated. Fewer family contacts were made, but movies an slides were shown at five of the six schools. At one school, over ha the pupils had never seen a movie. Literature was sent to anoth school, inaccessible even by jeep. A snapshot of pupils at each scho was taken. Contact list and map were brought up to date.

On October 6, 1949, a second letter, again friendly and "homey," wa written the families, telling about the school contacts, our personn changes, and expressing appreciation for the lack of fires thus far 1949. The damage from heavy grazing and the dangers of "lum sum" timber sales by famers to timber operators were described. was suggested that they plant a few walnuts that fall.

In 1949 only one fire occurred in the area. This was classed as smoker fire, but was not far from the railroad, and might have bee caused by a hobo or railroad employee. This was a very good recor especially since 1949 was much drier than the preceding 2 years.

In February 1950, the district ranger and I visited four school A talk was given to the pupils, stressing the damage done by rece floods (10,000 homeless in Kentucky, etc.) and the relation betwee forests, fires, and floods. The damages done by fire and the ways fi could be prevented were written on the blackboard by the ranger. mounted photo enlargement (6 by 8 inches) was presented to eac school and the negative left with the teacher in case pupils want copies. Contact prints were given the teachers individually. Ea family represented was supplied literature on forest care, tree plan ing, and fire prevention. Ten or fifteen residents were contact enroute. High water prevented travel to the other schools.

On April 6, 1950, a copy of the Forest Newsletter was mailed each family. This newsletter discussed in an informal way curre events over the entire forest. Many of these events were of special concern to the Sand Hill people, but it served to show th there was a lot of activity on "their" National Forest. Included course were items such as one about a man they knew paying da ages for some fire he had let escape.

The general objective of all this contact work was to get acquaint with the local residents, let them know we had not forgotten the as soon as we were out of sight, learn their problems, and have the learn some of our problems. Fire was not stressed; it was not oft mentioned, but it was included in the letters. On the contact she

r each family was listed items about children, occupation, health, udges, reputation, anything unusual. Always we tried to note me point that would be an entree on the next visit, or serve to recall e previous meeting. Before arriving at a given farm the contact eet was reviewed.

How well this work paid is perhaps best shown by the absence fires in the spring of 1950. Drier fire weather existed than in any ar since records were begun in 1937. On March 27, when the rest the forest had six fires that burned 760 acres (and others getting ady to pop when a heavy rain fell), the Sand Hill unit had no fires. n this day the danger meters went "over the top." In April there as a run of 20 days without rain. On April 24 meters again went er 100. The only fire in the Sand Hill unit this spring escaped om a railroad section crew burning right-of-way.

It is not planned to continue the intensive contact work done dur- g the last year and a half. We will show movies at one school vhich we missed) by fording Rockcastle River at low water, and rhaps visit several other schools once this year. Scattered family ntacts and small sales will be made, and free fuel permits issued. copy of each Forest Newsletter will be sent each family ("getting ings in the mail makes us feel important!"). Contact work will tapered off to fit the needs and our available work time. The sults in the Sand Hill unit show that fire prevention is mainly a of "getting acquainted" with the folks who can be a cause of fires.

[The Cumberland National Forest in Kentucky has had rather out- anding success in fire prevention. The average number of man- used fires for the 5-year period 1936–40 was 315. In 1949, in spite a more severe burning season, the number was held to 72.—Ed.]

Preventing Discoloration of Paint in Fire Towers.—Over a period of years this district painting the interior of the cabs on the fire towers has been cessary every 2 or 3 years. During the summer months the sun rays passing rough the windows cause the paint to peel on the window sills and to fade in or on the walls and trim. Any furniture in the direct rays of the sun is affected the same extent.

n the spring of 1948 the interior of two towers were painted at the same time d with the same type of paint. During the summer season when the towers closed the windows of one tower were given a heavy coating of Bon-Ami on inside of the glass while the windows of the other tower were left uncoated. e paint on the tower treated with Bon-Ami after 2 years is as bright as when was applied, while the tower not treated is due for another painting by the ring of 1951.

Since one of the first duties of a lookout when opening the tower at the ginning of the season is to clean the windows, it is a simple matter for him to pe the Bon-Ami from the windows in the process of cleaning.—Fred M. Weaver, *estry aid, Jefferson National Forest.*

DEBRIS BURNING ON THE OUACHITA

G. H. Stradt

Assistant Forest Supervisor, Ouachita National Forest

Every spring hundreds of brush burning smokes can be observe throughout the Ouachita Forest area, which contains over 2 millic acres under protection in Arkansas and Oklahoma. It is the time (the year when fields, brush, and trash are burned in preparation fc spring planting, a practice of long standing. Analysis of fire statisti points out that debris burning fires are more apt to escape during tl period of February 16 to April 15, depending somewhat on wheth spring is early or late, although burning begins soon after January and continues through April. The "escape" period includes that (the highest fire danger created by cured vegetation and strong, switcl ing March winds.

Legislation in both States requires reporting proposed burning i organized fire protection areas, as well as penalties for permitting fi to escape to other ownerships. Law enforcement is one method of aj proach, but experience over the past 10 years indicates other methoc may be better.

Table 1 gives a comparison of total fires classified as lightning an man-caused, and the relation between debris and man-caused fires fc calendar years 1940–49.

Table 1.—*Lightning and man-caused fires, and relation of debris to man-caused fir 1940–49*

Year	Total fires	Light-ning fires	Man-caused fires	Debris fires	Relation o debris to man-cause fires
	Number	*Number*	*Number*	*Number*	*Percent*
1940	167	47	120	30	25.
1941	120	47	73	15	20.
1942	130	34	96	13	13.
1943	369	114	255	35	13.
1944	180	116	64	9	14.
1945	67	22	45	5	11.
1946	165	36	129	27	20.
1947	245	71	174	22	12.
1948	191	84	107	16	15.
1949	111	23	88	13	14.
Average	175	59	116	19	16.

The highest number of fires during the 10-year period was recorde in 1943, when five or more occurred every month during the yea In 1945, an unusually wet year, the forest area had an all-time low i number of fires and acres burned during its 40 years of existence unde organized protection. The low number of debris fires is attribute to decreased farm activities, due to armed service and defense jc movement, together with low hazard conditions. In 1946 the mov ment was reversed with an accompanying increase in debris fires.

To reduce the number of debris fires, which during 1946 again xceeded 20 percent of the man-caused fires, a forest-wide campaign vas developed, to be effective with calendar year 1947 and continue hereafter with other phases of the prevention program. This cam-paign, which strives principally for on-the-ground contact, contains he following stipulations:

1. Continue thorough investigation of fires, with State or Federal aw enforcement.

2. Distribute brush burner cards for reporting proposed authorized urning.

3. Maintain record of all brush burner contacts by name and loca-ion, and give brief account of conversation for future reference.

4. Contact all new families and acquaint them with FIRE, as well s all applicable State and Federal forest regulations. Also recontact ld families when in their vicinity. Discourage burning by suggest-ng other means of disposal. If they intend to burn, go over the prob-em on the ground and encourage burning after 4 p. m., confined to mall areas on wet, damp, and low-danger days before February 15, vith sufficient control line, manpower, and suitable equipment.

5. Prepare news releases as a reminder of low and high fire danger eriods. Supervisor's office to prepare articles as a series and release y scheduled date.

The program has resulted in a substantial reduction in number of lebris fires over the past 3 years (a reduction of 18 percent in 1947 s compared with 1946, and 52 percent in 1949). Authorized burners re taking suggested precautions by burning smaller areas and at-empting to use natural barriers or previously constructed lines. In ddition, an increasing number of brush fires were observed during vet and damp days or late in the afternoon. A good detection and lispatcher system, together with residents reporting proposed burning, as also resulted in fewer false alarm runs.

During the spring of 1950 an additional item of prevention was dded to the campaign. In cooperation with Hot Springs National Park and Radio Station KWFC, a trial system of reporting class of ire danger and degree of hazard and risk for guidance of brush burn-rs was initiated. This system is not new, but it had not been used in his area before. This spring the records show continued progress in ontrolling debris burning. Of 87 man-caused fires, only 11 (13 per-ent) were from debris burning.

An example of needed contact was noted during the spring of 1948 when a resident living outside the Ouachita National Forest and south of the mountainous terrain, attempted authorized burning, without help or equipment, on some of his land located on a south slope within the forest boundary. He selected a day in March during a class 4 fire danger build-up. The fire quickly escaped and burned over 100 acres before suppression forces could control the spread. This individual was not accustomed to fire behavior in the mountains, even though he had practiced burning on flat and rolling terrain for many years. In this case a previous contact could have prevented a reportable fire and follow-up conviction in court.

The campaign will be continued not only from the standpoint of the debris burning problem, but also on the basis of its favorable effect on the entire fire prevention problem.

MULLIN DOZER TOOTH SHANK AIDS IN SLASH DISPOSAL AND FIRE LINE CONSTRUCTION

H. A. Mullin

Equipment Engineer, Region 3, U. S. Forest Service

Fire lines can now be constructed in rocky formations by using digging points attached to a specially built dozer tooth shank developed

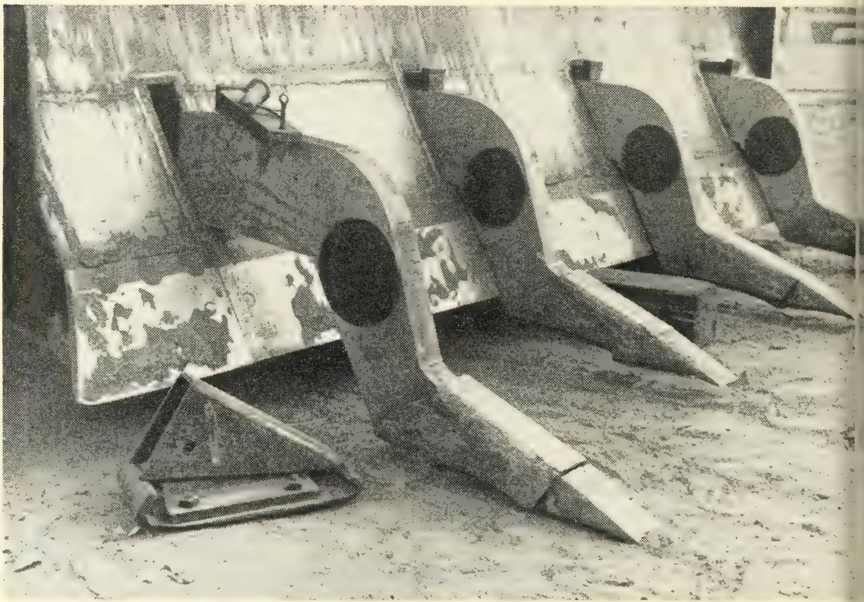


Figure 1.—Tooth shank installation, digging points, brush shoe, and method of installation in a bulldozer.

and tested by the United States Forest Service in the Southwestern Region. A tapered box welded through the cross-section of moldboard of any type dozer receives the tooth shank (fig. 1). The box is designed with a taper to accommodate a wedge that holds the tooth shank tight in the box. Four tooth shanks are considered adequate for most work.

Two styles of digging points were tested. A third type originated by the author has been designed, but not thoroughly tested yet. It is hoped that the new type will contain features the others do not have.

Figure 2 shows the installation of skid shoes used to float the moldboard 4 or 5 inches above the ground surface as an aid in bunching heavy slash after logging. Skid plates are reversible to compensate for

ear. The skid shoe design requires a 1-inch incidence and has a blunt nd to avoid penetration into the soil. The weight of the moldboard s carried on the heel of the shoe. This feature offers a means of packng or solidifying the soil while the shoe is skidding over the surface f the ground. The tooth shank protruding out in front of the moldoard reduces the danger of logs skidding on the moldboard when logs re pushed endwise. Large logs can be "floated" ahead of the dozer f the brush shoes are pushed under the log.

IGURE 2.—Typical (original) installation of brush shoes on dozer tooth shanks.

Digging points may be installed on the shanks by removing the brush hoes. This requires removing one bolt in each shoe. The same bolt is sed to secure the digging point to the tooth shank.

It is estimated that dozer efficiency is increased from 30 to 100 perent depending upon the type of earth formation. Digging ability is nade possible by the angle of the digging point. The top of the igging point angle in relation to the ground works on the principle f the wedge, to give mechanical advantage, less friction. The lifting orce of the teeth when used as a wedge is three to four times the ushing force. This accounts for the rapid penetration of the moldoard in extremely hard or rocky formations that straight or angle lades would not penetrate.

The tooth shanks and digging points act for the dozer moldboard n the same manner as the teeth on a shovel bucket: the teeth penerate and break up the soil or loosen the rocks before the moldboard trikes.

Sharp digging points are desirable on all digging tools. If sharp oints are maintained penetration into the soil and roots can be done

with a minimum of power. Working conditions will dictate the best digging point angle. Operators should keep in mind that the greatest mechanical advantage is obtained with the smallest tooth angle.

The tooth shanks can be installed on any dozer. Teeth have been spaced approximately 2½ feet apart on 10-foot moldboards.

It is recommended that for the greatest efficiency installations be made on tiltdozers. This makes it possible to adjust the digging point angle to match working conditions as well as compensate for tooth wear.

Sketches in figure 3 are presented to give the reader a third dimensional view not obtainable with photographs.

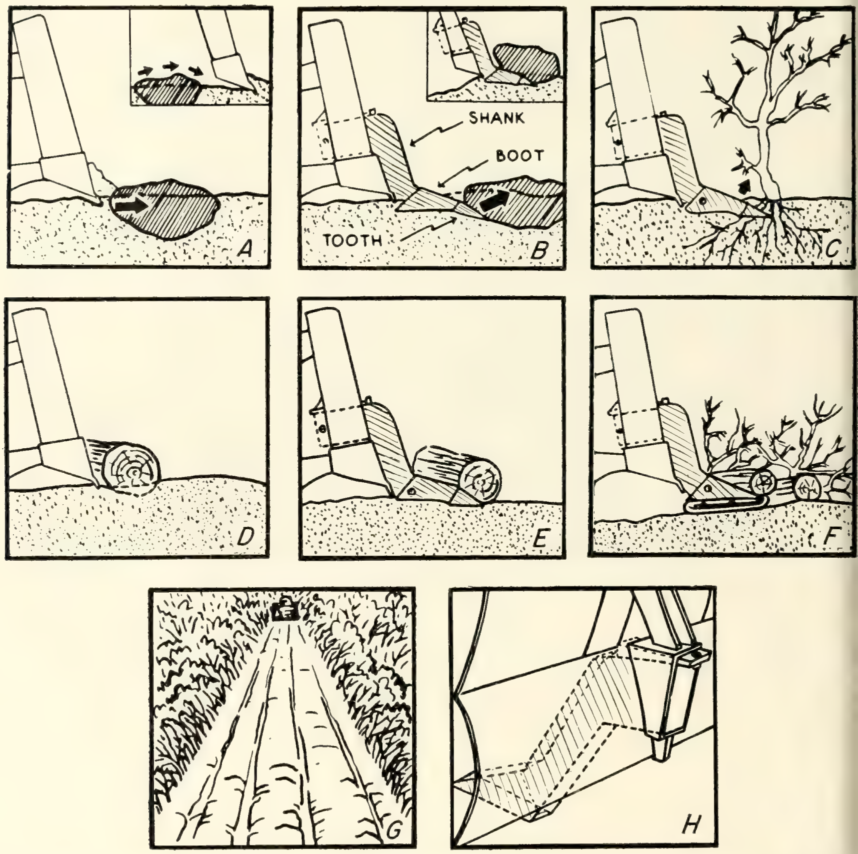


FIGURE 3.—*A*, Action of a conventional dozer moldboard striking a rock; arrow indicates the movement of the rock in the event the cutting edge does not slip over the rock. The conventional moldboard usually travels over the rock. *B*, Digging tooth being forced under the rock and applying lifting action from its power as a wedge. *C*, Action of a dozer tooth digging point directed at the roots of brush or small trees. *D*, Conventional dozer pushing a log partially imbedded in the ground. *E*, Lifting action takes place when log is pushed by dozer equipped with teeth. *F*, Brush shoe floating the dozer blade and picking up heavy fuels. *G*, Fire line construction or road right-of-way clearing in dense brush by dozer with digging teeth. *H*, Installation of a dozer tooth shank as seen from the back of a dozer moldboard.

This tool is not a scarifier. It penetrates like a wedge, lifts rocks nd small trees. In hard ground the tooth point pulls the moldboard itting edge into the ground making it possible to get a full load with minimum of tractor travel. This means more production in shorter me.

Cost of the installation complete, without digging points, for a D7 ill be $450 to $550 depending on the initial cost of the shanks and cilities for welding. The cost of this equipment has been found rough experiment and practical usage to be quite nominal in pro- ortion to time saved and production increase, gaged over a short eriod of time.

Use of Electric Wind Vane by a Coastal Plain Ranger District.—On the ickasawhay Ranger District of the DeSoto National Forest, the electric wind ne, which can be read down to units of 22½° of direction, has an important ace in fire suppression and prescribed burning work. The district is relatively vel and there are no mountains to influence the air currents. Fuel has a high te of spread index.

Information on accurate wind direction and its direction behavior is an es- ntial aid to the dispatcher in determining the number of crews and men to be spatched to a given fire where advantage can be taken of natural firebreaks, l wild fire burned areas, and prescribed burn areas. This is especially necessary en a number of fires are going at the same time.

The fire crew foreman normally makes some preliminary tactical plans as travels to a fire. The essential information on wind direction given him by e dispatcher aids him in organizing his preliminary suppression plans, and ien on the fire, in carrying out his suppression work. During the life of the e, wind direction and behavior changes are reported to him on the fire line.

During periods of prescribed burning work, an analysis of weather conditions work time in the morning will usually indicate the possibilities of carrying prescribed burning that day. Because of the relatively few days when pre- ribed burning can be successfully carried on, full advantage must be taken every such day. The electric wind vane is sensitive enought to indicate the nd direction and something of its behavior for the day to a degree not other- se interpretable. These early morning interpretations are essential for ministrative assignment of the prescribed burning crews to other work if escribed burning cannot be carried on that day. They also indicate times ien special attention may be necessary on those areas prescribed burned the v before, and which were allowed to burn into the night.

Experience has shown that on this district the most desirable and dependable nd for winter prescribed burning is the north wind that follows a good nter rain. It lasts for a period of up to about 4 days, with the final wind ift, usually clockwise, at night.

Occasionally this north wind begins to shift in the middle of the day and as rly as the second day after the rain. The first indications are slight shifts t readily interpreted on the ground, but definitely noticeable on the dial of e electric wind vane. When the fire dispatcher interprets the slight shift an indication of a wind shift, he notifies the prescribed burning crews by dio. The crew foremen can then plan for suppressing the prescribed burning it should become necessary, and thereby keep burning damage to a minimum.

In late summer and early fall when prescribed burning for seed-bed prepara- on and control of undesirable species is being conducted, the winds are not arly as dependable in direction and behavior as the winter winds. Wind rection varies considerably throughout the day and damage to tree growth more easily inflicted. Therefore, during this period the prescribed burning ews must be accurately informed about the wind direction and its behavior roughout the day.

A satisfactory electric wind vane can be purchased for as little as $25 to $35. is a good investment for a coastal plain ranger district.—Fred G. Ames, *rester, Division of Fire Control, Region 8, United States Forest Service.*

USE OF AIRCRAFT IN CONTROL OF LIGHTNIN FIRES ON BLACK HILLS NATIONAL FOREST

JOHN P. BURKE

Staff Assistant (Fire Control), Black Hills National Forest

A review of the last five fire seasons for the Black Hills Nationa Forest and surrounding protection zone revealed that 74 percen of the fires were lightning caused. Experience has shown that, witl sever burning conditions, most lightning fires in the Black Hill will put up at least a small smoke immediately after the strike. Th object is to take action on these fires before they grow to critical siz or shrink in the rain to become tricky sleepers. Quick action also lead to control of a fire while it is still burning only on the surface of th duff, thereby reducing mop-up time and expense. Unless promp action is taken on fires after (or during) severe electric storms, thei number and growing size can cause the suppression job to snowbal to unmanageable proportions. It is in the detection and suppressio of these fires that the use of aircraft has become important.

Aerial detection supplements lookout detection on the Black Hill National Forest, but will probably never supplant it. The lookout report approaching electric storms to the supervisor's office, an maintain a record of the path of the storms and of individual strikes If the fire danger justifies such action, a plane is sent out in time t follow the storm onto the forest, and it stays on the job as long afte the storm has passed as conditions warrant. When forest fuels hav had a chance to dry sufficiently to bring out sleepers, the plane i again used. As soon as a flight is scheduled, all lookouts are informe of the course to be flown and are thus alerted to exchange informatio with the aircraft observer by radio.

When the observer sights a smoke he reports it, immediately i possible, to the nearest lookout, suppression crew, or ranger. Merel being able to see the fire from the air, however, is not enough. Th observer must be able to gage the fuel type, slope, size and behavior o the fire, and other important factors, so that he has a basis for deter mining adequate manpower and equipment. When the fire is in location not positively identifiable by description, the observer give instructions to the crew to drive to a known point as near to the fir as possible. While the crew is traveling to this point the plane ma continue the patrol, or may be used for picking out a route to th fire. The observer's judgment from the air of the negotiability o roads is very important. Having reached the appointed place, th crew is directed to the fire by instructions over the radio from th aircraft observer.

In rolling country where the hilltops are timbered and no vantag points are available to the suppression crews, much time can be los in reaching the fire. Frequently a slight breeze will carry the smok

nto the timber or behind a hill, so that the crew can pass very close to he fire without locating it. If the observer can follow the crew from he air, he can stop them at the proper point.

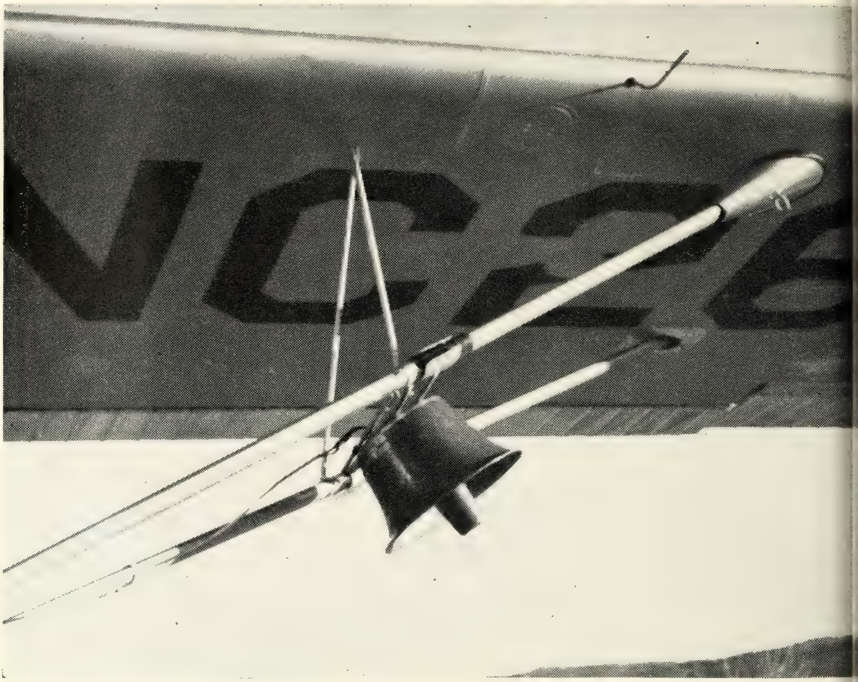
On old, narrow roads through heavy timber it is difficult to locate ı pickup truck, and extremely difficult to follow the progress of a nan on foot. During daylight hours in clear weather any reflecting surface may be used to reflect a beam of light from the sun to the plane. Signaling mirrors with aiming devices and instructions, salvaged from armed forces rescue kits, are effective for 10 miles or more. The aiming device is especially helpful in hitting a small target such ıs a plane at a distance.

If the fire is too far from a Forest Service crew for quick first atack, the lookout dispatcher may telephone the nearest cooperator. However, most local residents do not have telephones. The plane, herefore, was equipped with a loud-speaker so that the observer could request the needed assistance from the nearest cooperator, while the plane circled the ranch house or sawmill. The cooperator is informed of the location of the fire, its size, kind of fuel, and the size of crew nd kind of tools needed. The plane, by means of instructions through he loud-speaker, leads the cooperator to the fire. Arm signals are ısed by the man on the ground to answer questions by the observer, vho must anticipate the other's message in order to ask the questions. If more help is needed, the observer requests it by radio through the listrict organization or by loud-speaker from another cooperator. In any event, the cooperator is thanked, and informed that the fire s being reported to the ranger.

A high-wing monoplane with a low engine cowl is in our experience the most suitable type of aircraft. It provides excellent visibility, both to the sides and ahead; it carries ample fuel for 4 hours in the ıir; and air speed may be varied from 70 to 140 miles per hour. A four-place plane provides ample room for the use of radio, maps and other paraphernalia, while a smaller plane is noticeably crowded and reduces efficiency. A shelf over the baggage compartment of the fourplace plane provides mounting space for two 25-watt amplifiers weighng a total of 32 pounds. The left wing struts support a compact speaker, as shown in the photograph.

The walkie-talkie radiophone, type SF, is effective for temporary use n the plane. Fitted with an adapter plug and swivel lug attached to ın insulated wire antenna, the set can be turned on and off, as with he original antenna, by screwing the plug in or out. The fine wire ıntenna is extended out the window, which may be closed on it without lamage to the window. The outer end of the antenna is taped to the ving strut about 14 inches below the wing, with the tension sufficient o hold the wire fairly straight and with sufficient length inside the plane to permit manipulation of the set. The SF radiophone should be provided with separate microphone and headphone on cords so that he case containing chassis and batteries need not be held by the operaor. A kit providing the necessary parts is being supplied for the 1950 eason.

The present technique results in considerable saving particularly in he control of lightning fires. Because of it no great expansion of he present lookout system is contemplated. Consistently quicker deection of lightning fires, more positive first attack and quicker control,


The sturdy, compact speaker mounted on the left wing struts does not noticeably alter the flight characteristics of the plane.

and a smaller mop-up job result in savings which amount to several times the cost of plane hire. The added safety in controlling fires while they are still small is probably the greatest advantage, though it is hard to prove by statistics on the fires that don't get away.

[Aircraft operators must obtain CAA approval on each installation of equipment of the character described in this article. Additional information can be secured from the Forest Supervisor, Black Hills National Forest, Deadwood, S. Dak.]

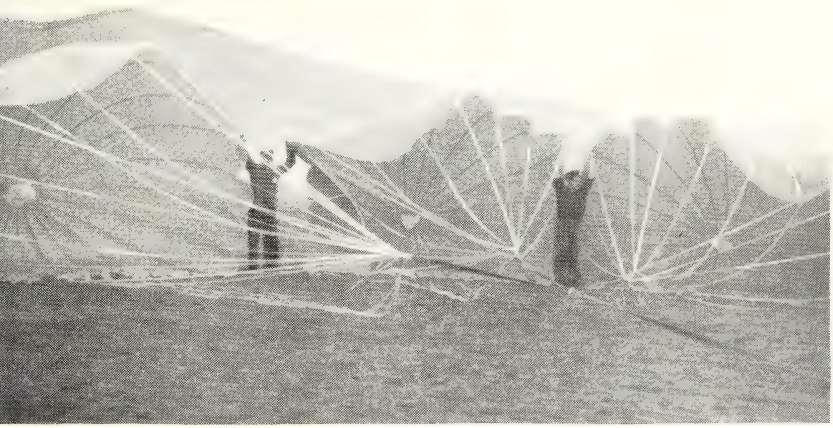
CARGO PARACHUTE EXPERIMENTS

FIRE CONTROL EQUIPMENT DEVELOPMENT PROJECT

Region 1, U. S. Forest Service

CLUSTER PARACHUTE

The cluster parachute consists of three standard 22-foot rayon cargo ·hutes attached to a common riser which carries the load (fig. 1). The



'IGURE 1.—Cluster parachute for loads up to 600 pounds. Note method of attachment to common riser.

listance from perimeter of each parachute to the container or load is 10 feet. Weight of the complete unit, packed in special container, s 66 pounds.

The cluster parachute was devised for carrying heavy loads of water, uel oil, or equipment. Although total weight (66 pounds) seems considerable, it is less than that of three parachutes packed in separate ontainers. Advantage of the large parachutes are savings in flying ime, less scattering of loads, and means of dropping equipment weighng over 200 pounds. When more than one conventional parachute is ttached at the load, the parachutes repel each other, causing a high rate of descent and an increase in the number of malfunctions due to ne canopy opening before the other.

Test drops made to date have been successful from a standpoint of lamage to cargo but rates of descent are somewhat faster than other special chutes (multiple parachute). There was also a tendency of his parachute to oscillate slightly more than other types tested.

Conclusions were that this parachute arrangement can be improve to obtain a slower rate of descent and perhaps less tendency to oscillat Because of the tests it is not recommended for general use at this tim

MULTIPLE-UNIT PARACHUTE

This project included development and test of a multiple-unit par chute for use with loads from 400 to 600 pounds. Development of roller platform for heavy cargo and the increasing demand to dro heavy loads of water, fuel oil, or equipment has created a need fo this type of parachute or methods of using standard freight chutes i clusters or pairs. Test drops of equipment, supported by two or mor standard chutes attached to the load at a central point, show that th escape of air at the perimeter causes the chutes to repel each othe resulting in a faster rate of descent and contributing toward oscilla tion in rough air. This was also the case, but to a smaller degree, wit the parachutes attached to a common riser.

The multiple-unit chute was constructed of three 22-foot rayo cargo chutes sewn together at the perimeter to form one large tr angular canopy. The resulting hole between the parachutes was en closed by a six-gore, conical chute sewn to the main canopies with zig zag stitching. The length of load lines was varied to allow the canop to ride flat, and the lines were attached to a single riser of doub thickness webbing. The load is attached to this riser.

The weight of this giant parachute is 71 pounds with containe Standard rayon cargo chutes weigh 24 pounds each, complete wit containers.

Drop tests of the parachute, with a 526-pound load, indicate ver good performance. Rate of descent averaged 23.5 feet per secon There was very little oscillation even in fairly rough air. Openin required 2½ seconds, which is fast enough for low-level dropping fo greater accuracy.

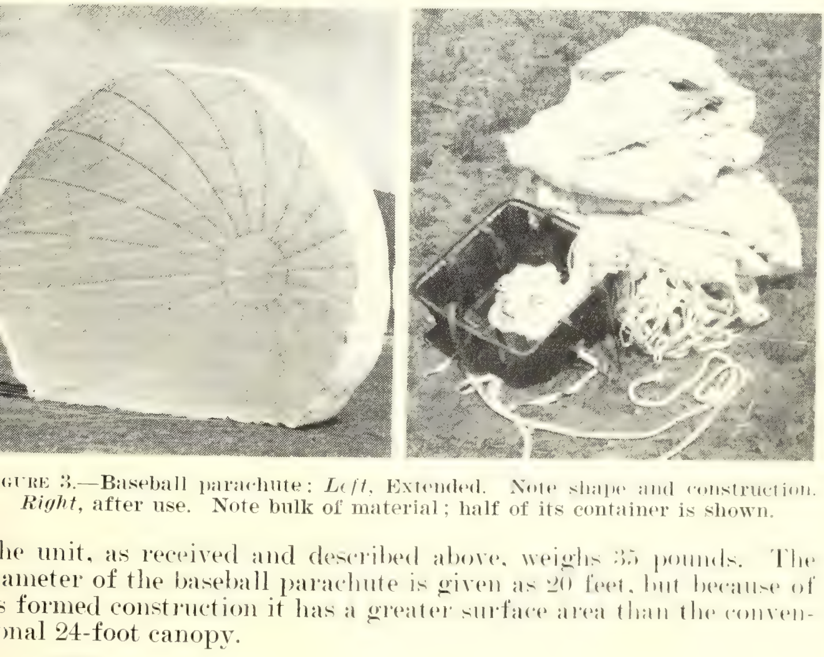
Figure 2 shows multiple-unit parachute as packed for use with heav loads. Single large container is easier to handle in plane than thre individual parachutes.

This parachute has a definite place and, of the three different type or kinds tested, gives the best all-round performance on heavy load It requires special construction and it is not believed that many of th units should be kept on hand except for special jobs.

BASEBALL PARACHUTE

Baseball parachutes are obtained from Army surplus and availabl for further orders. The parachute is bias constructed and formed, an has a muslin canopy with braided rayon lines. It differs from th conventional flat type canopy in that it assumes a half-round shap when fully inflated (fig. 3). There is no apex vent. The unit is ma chine-packed in a square, plastic-impregnated fabric container, th upper half of which is lost when the chute is pulled out. Repackin of the chute in the same type of container is impractical although man of them could be salvaged and repacked into a canvas sock, simila to the present standard cargo chute container but of a larger siz

IGURE 2.—Multiple-unit parachute in container shown with test loads in heavy drums, weighing 526 pounds.



GURE 3.—Baseball parachute: *Left*, Extended. Note shape and construction. *Right*, after use. Note bulk of material; half of its container is shown.

he unit, as received and described above, weighs 35 pounds. The ameter of the baseball parachute is given as 20 feet, but because of s formed construction it has a greater surface area than the conven- onal 24-foot canopy.

Test drops were very satisfactory. Average opening time was 1 seconds; average rate of descent, 23½ feet per second with 150-poun load and airspeed of 110 miles per hour. Little or no oscillation an very light landing shock were experienced.

We do not recommend loads over 150 pounds or airspeeds over 11 miles per hour, as opening shock is rather severe (indicated by broke line on one drop). The weight and bulkiness, when repacked int canvas containers, is a disadvantage for smoke jumper use or whe several packages must be carried on one trip.

ENLARGED APEX VENT

This project was undertaken to reduce the opening shock of para chutes, used with the long rope attachment, for timber drops. It believed by reducing the opening shock that a smaller and less ex pensive long rope may be used. At present one-half-inch rope, pre ferably nylon, is needed for dropping cargo in heavy timber.

A standard cargo chute was modified to provide a 35-inch-diamete vent in the apex. An 18-inch-diameter bungee ring was installed t close the vent after the opening shock. Modification costs totale $10.46 for test parachutes. This cost would be reduced considerabl if a number of parachutes were modified.

In test drops the parachutes equipped with the apex vent functione perfectly. Rates of descent were normal. In one drop the long rop (three-eighth-inch nylon) broke in two places but this was an old rop that apparently had lost the elasticity that gives it maximum strengt Also, the cargo was discharged at 110 miles per hour, which is we above the speeds normally used.

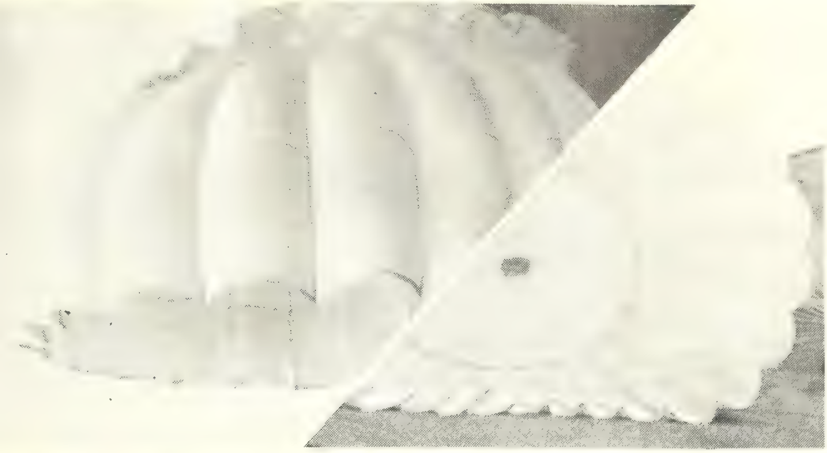
We believe it is possible to reduce the labor and material require to modify the standard chute by incorporating the bungee ring directl into the apex of the chute. This is to be tried.

UMBRELLA PARACHUTE

The umbrella parachute is a modification of the standard carg chute designed to reduce rate of descent and oscillation.

Modification of the standard chute consists of air vents, arrange in a circular pattern, around the upper third of the canopy. Th vents are cut across the panels of the parachute and material hemme on each edge for strength. These vents allow the escape of surplu air which normally is lost around the perimeter and through the ape vent. By "skirting" these vents, additional lift is created over th skirts and the top of the canopy (fig. 4). Skirts are positioned b secondary lines attached to the main lines of the parachute. It believed that the modification of a number of parachutes may be ac complished when damaged chutes are repaired. The additional mate rial needed for the skirts may be secured from chutes damaged beyon economical repair.

Tests of this chute indicate that further study is needed to perfec the modification, although rates of descent appear to be slower tha those of conventional parachutes and there is a noticeable decrease i the oscillation in rough air. Average rate of descent of the umbrell parachute on test drops made to date is 22 feet per second with 150 pound load.



[F]IGURE 4.—Umbrella parachute: *Left*, skirted lobes arranged in the canopy; *right*, arrangement of vents in upper third of the canopy.

12-FOOT RAYON PARACHUTE

This region recently purchased 200 12-foot orange rayon parachutes [(]Army surplus) for use with light cargo. Performance tests were [m]ade and the record established in case others become available or we [r]eceive requests for information concerning this type from other [r]egions.

The parachutes will be repacked in small canvas containers for use [i]n this region. Weight is approximately 1 pound. Initial cost of the [p]arachutes was $2 each.

In general, these small chutes are suitable for loads up to 50 pounds. [F]ragile loads, or water in 5-gallon cases, should not weigh over 32 [p]ounds. Opening characteristics were superior to the coffin-silk flare [c]hutes used extensively in this region for smoke-jumper packs, light [l]oads of subsistence or water, and other equipment.

ROLLER PLATFORM FOR DISCHARGING AIR CARGO

Fire Control Equipment Development Project

Region 1, U. S. Forest Service

The region has been using two Douglas C–47 airplanes extensivel for aerial freight delivery and smoke-jumping activities. Cost pe hour is but little more than that of the Fords and Travelairs becaus of the faster cruising speed. The big planes do require, however, mor maneuvering time for dropping cargo in difficult areas. The rolle platform was built to enable freight droppers to discharge heavy carg or multiple bundles quickly and easily at the proper time. The ad vantages are: (1) Reduction of flying costs; (2) less scattering o bundles on ground; (3) greater dropping accuracy; (4) ease of han dling heavy cargo such as a barrel of fuel oil; (5) safety of operatio

The platform frame is constructed of welded, square steel tubin arranged to support ball-bearing rollers made of aluminum tubin Twelve rollers were used in this model but drawings and specification are being revised to include two additional rollers. These addition rollers will be installed in the two outside panels in line with the secon roller of the center panel. This will provide five rollers on the outsid edge instead of the four shown in figure 1.

A sheet of aluminum is riveted to the framework on the upper sid and slots cut for the rollers to work in. The rollers extend approx mately one-fourth inch above the platform. Pins on the front co ners position the platform in the door of the plane.

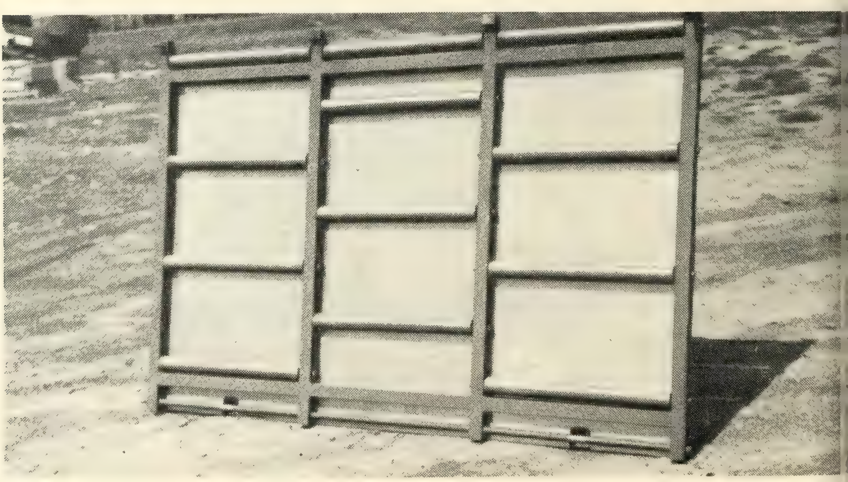


Figure 1.—Bottom view of platform showing construction details. Pin in fro corner is for positioning platform in door of plane.

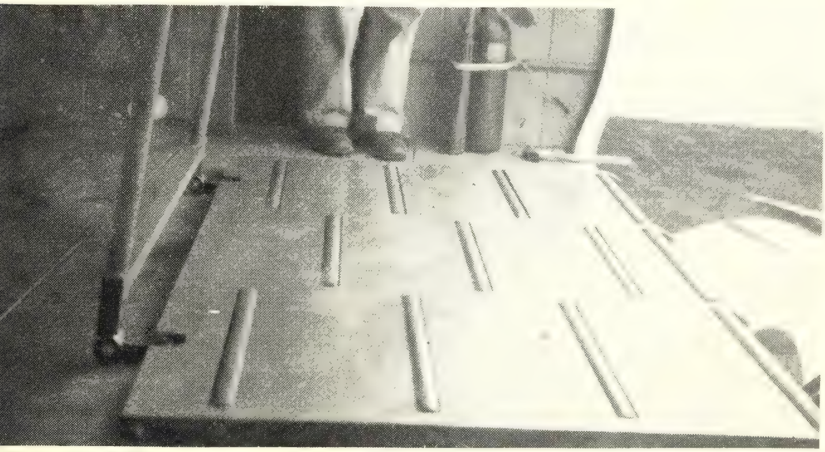
The roller platform has performed successfully in all test drops. Ve have discharged loads weighing 1,196 pounds with one man only n the lifting bar. With multiple bundles, the practice is to space hem as far apart as possible and following each other as they leave he door. Parachutes fouled each other temporarily in opening on ne test, but loads were undamaged on landing.

Total cost of the development was $353. Similar roller platforms nay be constructed for approximately $200 for labor and materials, vith smaller platforms costing correspondingly less.

As a result of tests made on this unit, we plan to construct a roller latform for use in the Ford and Travelair airplanes. Although maller in capacity, the roller platform in these planes will discharge argo faster and easier than present methods.

The lifting device consists of tubular handles, with rollers made of all-bearings, and offset arms slotted to engage a bar in the rear of he framework (fig. 2). Not shown in the picture is a rubber pad vhich is installed between the floor of the plane and the platform. 'his rubber pad engages the rollers when the platform is lowered to revent the rolls turning while the platform is being loaded for a rop, or until the platform is raised to discharge the cargo. This is n important safety precaution and makes it easier to load the platorm in flight.

When the platform is raised, the rolls are free to turn, and the inline is sufficient to cause loads to roll by gravity. A sheet of heavy ardboard under odd-shaped or roped bundles will allow them to roll ut easily.



GURE 2.—Platform in flat position in door of airplane. Pulling the handle at left to the floor raises platform to unloading position.

CARGO DROPPER'S SAFETY HARNESS

FIRE CONTROL EQUIPMENT DEVELOPMENT PROJECT

Region 1, U. S. Forest Service

The development of a safety harness for use by cargo droppers has been discussed many times. Fire control personnel have been in agreement that it was badly needed but objections to its use were as follows:

1. It hampered or restricted movement of the cargo dropper in discharging bundles of air cargo unless the safety line was long enough to allow free movement inside the airplane.

2. With a restraining line long enough to allow free movement there was the possibility of cargo droppers falling part way or entirely out of the airplane door.

3. If a parachute was not worn, there was always the possibility that, in an emergency during low-level flight, it could not be attached in time to do any good.

4. If a parachute was worn with the dropper's safety belt, there was a possibility of the parachute being opened accidentally while handling cargo, and the canopy opening outside the airplane. In this event, droppers did not want to be tied to the airplane.

It had been proposed that a bar or strap be hung across the door of the airplane for the dropper to grab in an emergency. This substitute hampered the discharging of cargo and was never considered a satisfactory arrangement.

Discussions brought out several suggestions and possibilities which have been combined in the cargo dropper's safety harness described here.

The safety harness has been designed to use with airplanes equipped with overhead cable running lengthwise of the airplane. This arrangement is satisfactory for use by smoke jumpers or in freight delivery, and requires only that parachute static lines be of the proper length. The safety line is adjusted to allow the dropper free movement in working the cargo at the door, but in the event he should fall the pull on the safety line swings him back towards the center of the plane to a position directly under the overhead cable. Length is such that the dropper cannot fall out of the door. Movement in the plane is accomplished by sliding the cable snap along the cable as necessary.

The harness is designed to be quickly removable in an emergency. The quick-release fastener releases shoulder and waist straps immediately when struck with the hand. There are no loops in the harness to slide out of. Until the harness is released, the parachute cannot come out of its container even though the rip cord should be accidentally pulled.

Tests of the dropper's safety harness have been satisfactory and the harness is approved by experienced men who tried it.

argo dropper's safety harness: Front view showing quick-release box; back view showing arrangement of harness to prevent parachute from being opened accidentally.

Drawings and cable installation instructions are available to those ho care to make tests of the harness from the Regional Forester, ederal Building, Missoula, Mont.

[A recent report of a contract cargo dropper's life being saved by arachuting from a crashing plane only 150 to 200 feet above the round indicates that wearing of parachutes by cargo dropping pernnel has more merit than generally believed.—Ed.]

PORTABLE LINEN HOSE WINDER

Austin H. Wilkins
Deputy Forest Commissioner, Maine Forest Service

The Maine Forest Service uses large quantities of 1½-inch line hose in 100-foot lengths with slotted lug aluminum alloy I. P. T. cou plings. In handling this kind of hose, fire wardens have long been in terested in some portable type of hose winder. Many have devise home-made models but none which could be declared as suitable fo standard equipment.

Double-rolled 100-foot length of linen hose; female end overlaps and protects ma coupling threads.

In the winter of 1948 the writer attended a forest fire protection meeting of the Canadian Society of Forest Engineers at Fredericton, New Brunswick. During the meeting a portable hose winder for linen hose was displayed. Through the courtesy of the New Brunswick Forest Service a blueprint of this model was made available to the Maine Forest Service. With some remodeling of the New Brunswick sketch, Maine has made a number of these hose winders, which are now considered standard equipment for each forest fire warden's headquarters.

These hose winders are relatively simple to construct and cost of materials should not exceed 10 dollars. The main office has been securing the hardware and sending it to the warden where the rest of the construction work is completed. There are no patent rights on this winder and anyone interested can easily make his own.

In Maine the wardens are instructed to roll linen hose double with the female end longer so as to overlap the male coupling and form a guard for the threads.

Some wardens have been using this winder satisfactorily for quickly picking up wet and dirty hose off the fire lines to be loaded on to trucks and taken to the storehouse for cleaning and drying. When rolling up clean and dry hose at the storehouse, each roll is tightly wound and ready for service or storage.

This hose winder is not designed for 1½-inch single or double jacket rubber-lined hose. However, it can be used by making the side pieces of the frame above the sockets a little longer.

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MICHIGAN POWER WAGON FIRE UNIT

GILBERT I. STEWART

Supervisor, Michigan Forest Fire Experiment Station

The power wagon as used by the Michigan Department of Conservation for forest fire control is a four-wheel-drive truck that equals wheeled tractors in its ability to traverse difficult terrain. The commercial truck requires considerable refinement to adapt it to fire control purposes inasmuch as it is a standard cargo carrier.

Michigan power wagon fire unit.

The basic design was completed at the Michigan Forest Fire Experiment Station. Field experience over the past 3 years has added to the final machine and as the unit is now issued, it is the result of work and suggestion by the entire fire organization. The truck lends itself very well to use as a medium tanker for fire fighting. To fulfill this assignment, the following installations have been added to the commercial truck:

1. Drive shaft leading from the transmission and driven by the commercial attachments for the rear power take-off. Cross members were added to support bearings and the drive shaft, which is actually a jackshaft lying within the chassis frame.
2. Complete armor around the entire body. This includes a radiator grill and protection for the headlights, heavy angle members attached to the fenders and running boards, and a rear bumper and trailer hitch.

3. Slip-on tank unit mounted on a skidlike base. It is removable and may be repositioned exactly by indexing points. The tank unit also includes a high-pressure pumping unit mounted on a steel deck behind the tank. The pump is driven by a multiple V-belt system from the special drive shaft mentioned. A hole in the truck deck permits passage of the belts from the shaft to the pump sheave, and a guard covers the belt system. Capacity is 15 gallons per minute at 600 pounds pressure. Also included in this pumping system is a tank filler operating on the ejector principle. Its purpose is rapid refilling of the tank at supply points.

4. Live reel for hose storage and pumping service.

5. Full radio equipment. This consists of an FM unit operating on a frequency of 46580. The radio instruments are in a steel case mounted on top of the tank. Cables run from the instruments to controls on the dashboard near the driver. They are contained in waterproof and steel casings.

6. Complete tool equipment for pumping service, maintenance, and field upkeep. This includes all pump accessories, nozzle gun, etc. All of these items are contained in a sturdy tool box with recesses for each part. Full operating instructions are mounted in a watertight frame in the lid of the box. For purposes of compactness and utility of space, the tool kit is carried on top of the radio case and below the level of the cab.

This outfit is assigned as initial attack equipment. The tank capacity of 300 gallons permits working time of 1 to 1¾ hours depending on fuel types and skill of operator. Accessory equipment consists of two hand-operated plunger pumps, three shovels, and one ax. Two seats may be mounted at the rear of the body for extra men. The normal crew need not exceed four men.

This model of power wagon and the additional equipment has been under development and production by the Michigan Department of Conservation since 1946. Twenty of these are now in service. Full print specifications have been completed as well as tooling for production. Patterns for all necessary castings are completed. Total cost averages about $3,300, not including radio equipment.

Experimental work to extend its usefulness in fire control is being continued at the Forest Fire Experiment Station. Included in the experiments is the attachment of hydraulically operated plows at the rear of the truck, to be used when possible in line building.

It should be borne in mind that the power wagon does not compete with crawler tractors and plowing units. Its development was intended to provide a relatively fast tanker that would not be roadbound. It actually supplements the crawler tractor and plow. These two units cooperating as a team are capable of effective action, especially at heads of fires where line must be built or where critical sectors must be held while line is being built and at critical points not hitherto possible of attack.

Additional information on this unit may be obtained from State Department of Conservation, Lansing, Mich., or Michigan Forest Fire Experiment Station, Roscommon, Mich.

SOUTH CAROLINA'S TYPE C–150 LIGHT SUPPRESSION PLOW

J. A. McLees

Fire Control Engineer, South Carolina State Commission of Forestr

This plow was designed and developed by the Engineering Section Branch of Forest Fire Control, South Carolina State Commission o Forestry to fill the need for a light suppression plow that could cop with conditions encountered in the heavy and wet soil types of th coastal plains region. Development was started in January 1950, an the plow was ready for "fire test" during the spring blow-up. Specifications are as follows:

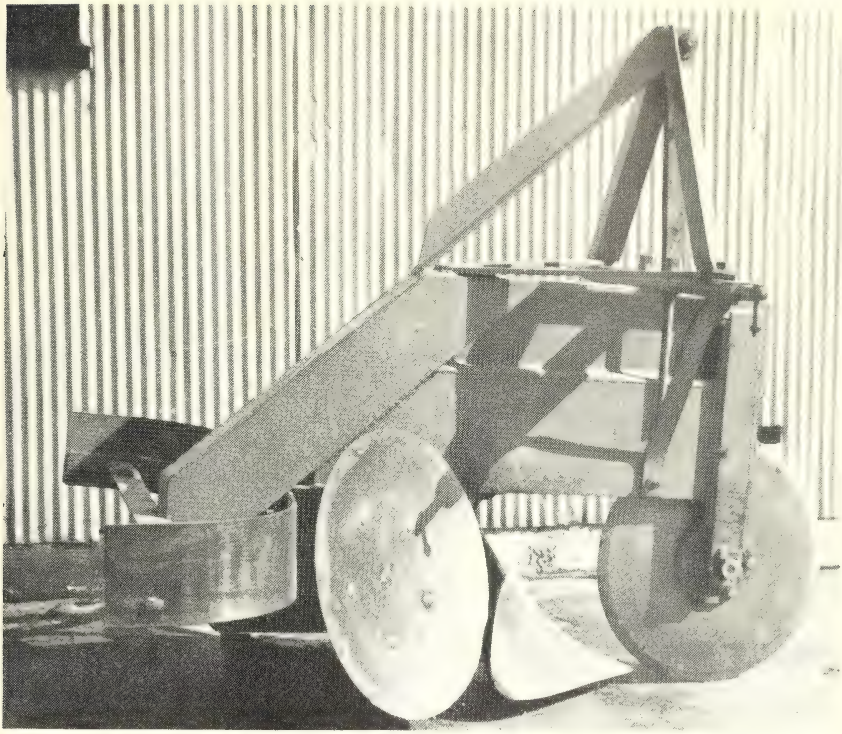
Weight	515 pounds.
Coulter:	
Construction	Cast steel (South Carolina State Commission of Forestry foundry pattern).
Outside diameter	18 inches.
Shape	Cast taper, machine beveled.
Hub	Steel plate, bronze bushing.
Lubrication	Zerk fitting.
Middlebuster point	Cast steel (South Carolina State Commission of Forestry pattern).
Disks	18-inch diameter, farm type.
Main beam	Design; high torque resistant bo beam.
Draw bars	Same as Dearborn Cross draw bar.

The middlebuster plow point is not of commercial manufacture, bu is of cast steel from a pattern developed by the commission.

Pilot models of this plow carry coulters of machined steel plate Production models are fitted with a heavy steel coulter, machine beveled, and cast from the commission's aluminum pattern.

The 18-inch disks are carried on heavy duty, dust-sealed hubs, cas from the commission's foundry pattern. The hubs are fitted wit Timken bearings. Disks are of commercial manufacture.

The firebreak cut by the unit has an average depth of 4 inches wit a cut width of 30 inches. The cut section together with the variabl throw provides an effective firebreak of 42 to 60 inches, dependin upon the soil condition. The plow constructs an exceptionally clea line and its sturdy construction is an advantage over many othe types of light suppression plows tested under South Carolina conditions. It is adequately drawn by Ford or Ford-Ferguson type tracto equipped with bombardier half track system or the H. G. crawle tractor in the 20 horsepower range.



Light suppression plow with specially designed middlebuster plow point and coulter.

Portable Electric Megaphone.—Late in the fall of 1949 a portable electric megaphone was loaned to the Superior National Forest by a commercial company, for testing the feasibility of broadcasting messages from airplanes to ground crews engaged in fire suppression. The short time remaining in the fire season left little opportunity to make exhaustive tests and come to any very definite recommendations. However, some tests were made from each of the three Forest Service planes.

Reception, volume, and clarity was very good from the two-place Piper Cub at elevations near 500 feet. At 1,000 feet reception was fair, while at 1,800 feet it was intermittent, i. e., fair if plane was up wind from the listener, and not audible if the plane was down wind.

A test was afforded from the four-place Stinson during the search for a lost hunter. With the plane flying at an elevation of 500 to 800 feet over an area of about four square miles, the searching party was able to clearly hear the announcement that the lost man had been found. On another occasion, the megaphone operated ground-to-ground points during a stormy night trying to call a lost hunter out of the woods. It was later learned that the hunter heard the voice of the searcher but, it being night, was afraid to leave his fire.

When the megaphone was operated from the Noorduyn-Horseman nine-place plane, reception was poor. This was probably due to the high noise factor from the plane and the elevations required for flying the large-sized craft.

From the few tests made, the Superior Forest believes the megaphone would be very practical in talking to fire crews from small planes such as the Cub and Stinson. It would also be practical in large fire camps for amplifying instructions and announcements.—W. J. Emerson, *forester, Fire Control, Superior National Forest.*

PRELIMINARY REPORT ON THE USE OF A TRACTOR-PLOW IN THE SOUTHERN APPALACHIANS

R. D. Williams

District Ranger, Chattahoochee National Forest

An H. G. crawler tractor with a middlebuster plow has been used in fire suppression on the Armuchee Ranger District since the spring of 1949 with promising results.

The Armuchee is the westernmost district of the Chattahoochee National Forest situated in northwest Georgia. The area is characterized by a series of long linear ridges rising up to 800 feet above the floors of the intervening, wide agricultural valleys. Most of the 146,525 acres protected lie in the ridges where soils are stony and large rock outcrops are frequent. Topography is rough and slopes are steep. About one-fourth of the timbered area is a hardwood type, and the other three-fourths yellow pine-hardwood. Underbrush is heavy and fires in the predominant leaf-needle litter burn with a high rate of spread and medium resistance to control. Slash areas resulting from heavy logging of private lands, and sedge grass and advanced reproduction on numerous abandoned fields interspersed throughout the area, form the most explosive fuels.

During the 5-year period 1944–48 an average of 31 fires burned 784 acres annually. Prior to 1949 suppression was handled entirely with hand tools by the district ranger, 2 seasonal Fire Control Aids, and 7 voluntary fire wardens with trained "pickup" crews. The original force has been retained. The tractor-plow was added to strengthen the organization. Although approximately 10 percent of the protected area is too rough for tractor operation, fires occur infrequently in the rougher sections, and during 1949–50 the unit could have operated on every fire that occurred.

The tractor-plow assigned to the Armuchee District has a total weight of 5,130 pounds, total length with plow lowered of 14 feet, and maximum width of 5 feet. Treads are 10 inches wide. The 4-cylinder motor gives tractor speeds at governed motor speed of 2.02 miles per hour in low gear, 3.19 miles per hour in second, 5.25 miles per hour in high, and 2.35 miles per hour in reverse.

To the commercial tractor were added: Heavy radiator guard; brush guard rising 3 feet above the operator's seat; safety guard over the top of the treads; front bumper reinforcement of 300 pounds of railroad steel to counterbalance the weight of the plow; and a spotlight and rear-mounted headlight (or taillight with clear lens), which were essential for night work. Mounted on the tractor is a back-pack pump, drip torch, three council rakes, short-handled shovel, and Pulaski tool. A standard six-man tool box is mounted on the carrier truck.

The plow weighs 398 pounds and is raised and lowered by a hand winch. It is adjusted for depth of line by changing the pitch of the beam at the clevis. The plow has a 24- by 32-inch moldboard and 36-inch wingspread. In most soils it constructs line 6 inches deep at the center and 54 inches in width, including throwback.

The unit is transported on a 1½-ton stake truck with a 7- by 9-foot flat body and a 5-foot ramp sloped to a 21-percent grade. Portable runplanks complete the ramp to the ground. The truck can travel safely at 45 miles per hour on good roads and the unit can be unloaded and placed in operation by two men in 1 minute (fig. 1).

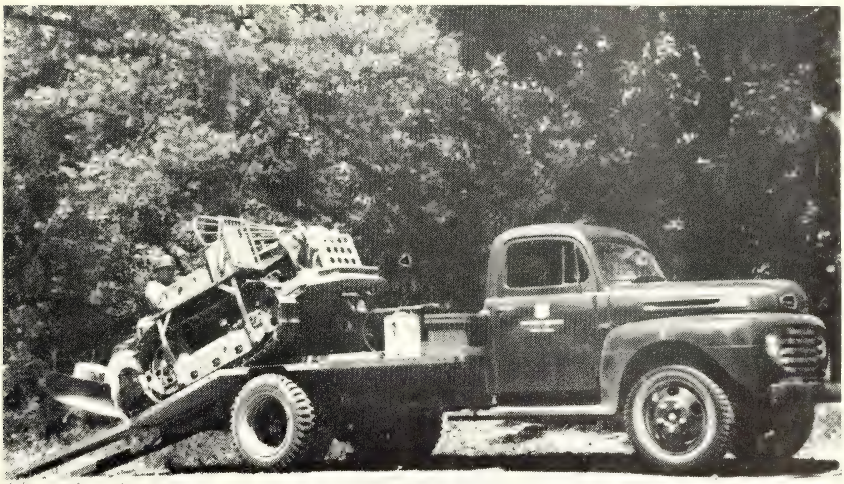


FIGURE 1.—Unloading the H. G. crawler tractor with middlebuster plow. The unit can be unloaded and placed in operation by two men in 1 minute.

The tractor operates efficiently downhill on slopes up to 70 percent, uphill on slopes up to 40 percent, and sidehill on slopes up to 45 percent (fig. 2). Where slopes are too steep for sidehill and uphill operation, the tractor is backed uphill and builds line downward. The outfit performs satisfactorily in rough, rocky terrain and good results have been obtained on night fires.

Organization plans call for immediately dispatching the tractor-plow to every fire in "plowable" area as shown on the control map. When the need is indicated, a warden crew is also dispatched to handle sections of the line too rough for the tractor, and to perform mop-up so as to release the tractor crew for another fire. On class 2 and 3 days, the tractor crew consists of the operator, backfire torchman, and follow-up man with a council rake and back-pack pump. On class 4 and 5 days, two additional men are carried to back up the line. A front scout is necessary if the country is very rough and is always necessary at night. Most fires are controlled by the parallel method as our fires seldom crown. Fusees were found too slow for line firing but drip torches have been used with good results.

From January 1, 1949, to June 30, 1950, 51 fires have occurred on the district. The tractor-plow was dispatched to 36, or 71 percent,

FIGURE 2.—Downhill operation on a 70-percent slope. The tractor performs well in steep, rocky terrain.

of these and operated on 29 fires, or 59 percent. It was not needed on arrival at 7 fires and was not dispatched to others through error in judgment or because it was known that it would not be needed. The unit built 895 chains of line at an average rate of 50.6 chains of held line per tractor-hour and a held line average of 16.9 chains per man-hour on the tractor-built sections. Table 1 shows the results obtained on the 29 fires occurring in 1949–50 and 129 fires controlled entirely by hand during the period 1944–48, inclusive. Class A fires and fires occurring on class 2 days were eliminated from the analysis as these are usually easily handled and offer no test of suppression methods.

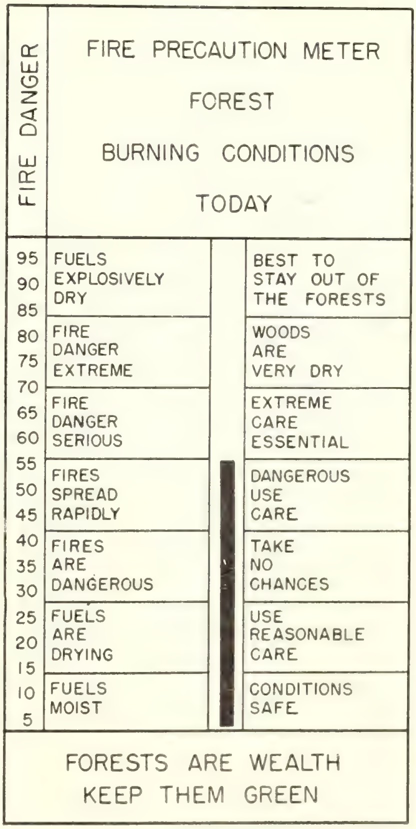
TABLE 1.—*Average size of fire and average time on suppression for hand-tool and plow control on class 3 and 4 fire days*

Fire day and control method	Average size of fires			Average time on suppression		
	Area of attack	Final area	Increase	Line construction	Mop-up	Total
	Acres	*Acres*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Class 3:						
Hand-tool	10. 3	18. 8	83	14. 53	19. 67	34. 20
Plow	8. 8	11. 4	30	5. 74	12. 00	17. 74
Class 4:						
Hand-tool	18. 6	46. 9	152	36. 32	29. 00	65. 32
Plow	8. 6	12. 3	43	5. 98	18. 00	23. 98

Plow-controlled fires are smaller at initial attack because the unit is immediately dispatched, whereas warden crews are more slowly gathered and get-away time is longer. The final average size is considerably smaller and the advantage of plow over hand-tool control increases sharply as fire danger rises.

Operation and depreciation of the tractor and plow was established at $5.25 per hour. Based on wage rates now prevailing in this locality, the average plow-controlled fire was suppressed at a cost of $22 as compared to $36 for the hand-tool controlled fires. Past occurrence of 26 fires annually on class 3 and 4 days, class B and larger, indicates annual savings of $364 in suppression costs. On this basis alone the equipment is a paying investment. However, greatest saving is the reduced acreage burned and reduction in possibility of large disastrous fires. The outfit, too, has a definite prevention value. Job fires which were becoming a problem in one area practically stopped after the tractor was persistently used in place of hand labor.

Fire Precaution Meter.—The more the traveling public and local people become aware of fire danger conditions, the more we can expect caution will be used by people in forested areas during the fire season. For that purpose, a fire precaution meter was devised on the Helena Forest in 1937. Both of the local daily papers, Montana Record Herald and Helena Independent, agreed to carry the meter each day during the fire season. It attracted immediate attention and comment by local readers, and the two papers came back with a request for it in 1938. The first printing was accompanied by a short article explaining the purpose, etc. It was devised as a representation of a thermometer with a line in the center to represent the mercury tube.



Recently revised slightly to fit the present class 100 danger meter, and with some change in wording, it is now being carried in Coeur d'Alene, Idaho, and Spokane, Wash., dailies during the fire season. Similar precaution meters could well be devised for use in daily papers in other regions and parts of the United States where fire conditions and man-caused fires are a problem during varying seasons of the year.

The meter has little value other than in daily papers. It carries a very brief description of each of the seven fire danger levels in the left-hand column. Opposite are briefed measures of precaution which should be observed by people living or traveling in forested areas. A studied attempt was made to carry the message to the readers in language readily understandable to anyone able to read.

It must also be remembered, once such an arrangement is worked out with a newspaper, an obligation exists to decide on what danger rating is to be run and notify the person who is to receive the information in plenty of time to go to press.—V. L. Collins, *district ranger, Colville National Forest.*

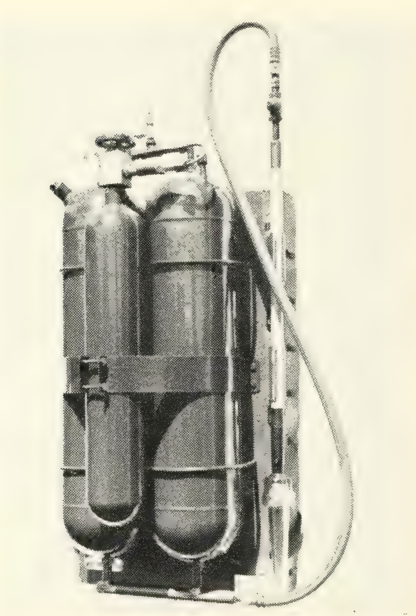
CO_2 BACK-PACK OUTFIT

A. B. Everts[1]

Fire Staffman, Snoqualmie National Forest

The subject of pressurized back-pack outfits has come in for consid erable discussion by forest protection men. Usually the discussio centers around the use of a CO_2 cartridge for discharging liquid fron a pressure cylinder. The disadvantage of the cartridge idea is tha the pressure does not remain constant. In order to have sufficier pressure to properly expel the last of the extinguishing agent, it i necessary to overcharge the cylinder at the beginning of the operation In the dry powder type of extinguishers this problem is provided fo by using a heavy cylinder for the powder. This, obviously, increase the weight and would be undesirable in a back-pack outfit.

Test data were obtained on a constant pressure back-pack outfi constructed mostly from surplus materials. To check pressure dat the test outfit was provided with a pressure gage. This gage would b unnecessary for field use. The price a manufacturer would have to ge for such a unit, using new mate rials, would probably be out o reach for most protection agencie Nevertheless, performance data are interesting.



The CO_2 bottle in the center will expel the two presure tanks better than seven times, maintaining a constant pressure of 100 pounds. Plastic foam nozzle is shown.

Two surplus, stainless stee shatterproof oxygen tanks with combined capacity of 4¾ gallon were fastened to a plywood pack board. These tanks were tested t 600 pounds and provided with safety release set at 200 pound

A 10-pound CO_2 bottle (als surplus) containing 3¾ pounds o CO_2 is mounted between the tw tanks.

A regulator valve (surplus) se at 100 pounds is screwed into th outlet of the CO_2 bottle. Thi valve has a soft blow-out disk a is common with such regulators Thus, there are two safety devices This valve allows the CO_2 to fee into the pressure tanks through copper tube, keeping the pressur constant at 100 pounds.

The two tanks are joined at th top and bottom by tubes so tha

[1] Recently transferred to the Division of Fire Control, Northwes Regior United States Forest Service, to handle fire control equipment.

only one filler cap is needed. This arrangement also permits equal pressure distribution.

The nozzle is a 2-foot tube which can be provided with straight stream and fog or foam tips of any desired design or capacity. A press button, spring tension valve, operated by the palm, controls the discharge. There is no doubt that this arrangement allows more efficient water application than the hand-operated pump common on back-pack outfits.

The weight of the unit, fully charged with liquid and CO_2, is 65 pounds, or 10 pounds heavier than the conventional units.

With the temperature at 48° F. the 3¾ pounds of CO_2 expelled the two tanks eight times. On the last charge the pressure dropped to 20 pounds.

Using a small plastic foam nozzle and one quart of high expansion mechanical (liquid) foam and the rest water, 35 gallons of foam was measured. Thus, the potential foam capacity of the CO_2 is 280 gallons. The unit operated for 2 minutes, producing foam at the rate of 17.5 gallons per minute.

The unit operated 3¾ minutes with a straight stream tip; 1¾ minutes with fog. These figures mean little, however, as the size of the orifices in the tips determine the length of operation.

The disadvantage of a pressure unit of this kind, besides the cost, is that the CO_2 bottles have to be recharged. In most locations this entails shipping the bottles to a refilling plant. Open top converters, which could be recharged on the ground with dry ice, would be an improvement. Using wet water and the proper fog tips, the unit should be an effective outfit for extinguishing fires in overstuffed furniture and mattresses, a common type of fire for city fire departments. The foam unit should be effective on restaurant range fires, involving burning grease. On the forest fire line, however, it is a little too complicated and too subject to injury. For motor patrolmen, it might have a value.

For home use applying 2-4D, DDT, or whitewash with a fog tip, it definitely has possibilities—approximately 32 gallons of liquid easily and effectively applied with 3¾ pounds of CO_2. If the unit had an open top converter, it would cost about 12 cents to recharge the converter with dry ice.

[Additional information may be obtained from the author, in care of Regional Forester, Post Office Building, Portland 8, Oreg.]

A SIMPLE LOOKOUT TRAINING AID

GLENN E. BRADO
District Forest Ranger, Sawtooth National Forest

Each time a new man is placed on a lookout he has to be trainec in the various phases of the lookout job. One of his first duties i to "learn the country." This may be done in a number of ways bu we have found the training gadget shown in the photograph to b very useful.

Training aid being used; dimensions are 36 by 12 by 4 inches.

The framework of the training aid is ¼-inch iron rod, welded tc gether. The frame may be made any convenient size but should b long enough to enable the trainer and trainee to stand side by side The cross hairs on one end of the frame are attached to movable sleeve which are locked in place with one-quarter-inch nuts. This provide for adjustment in making the lines of sight parallel. The eye piece are one-quarter-inch flat washers welded in place; and the cross hair are made of length of fish line.

To adjust the training aid, simply place the frame on some con venient support with the rigid cross hair centered on some prominen object a mile or so away. Then, without moving the frame, adjus

the movable cross hairs until they are centered on the same object. If the eye pieces are 30 inches apart and the lines of sight are parallel, the error will be negligible for lookout training purposes.

The training aid can be used by the training officer in pointing out features of terrain such as creek bottoms, ridges, and prominent landmarks, or by the ranger or other inspecting officer in checking on a lookout's knowledge of the terrain.

In training, the instructor and trainee stand side by side. The instructor should control the movement of the frame and hold his cross hair on the particular topographical feature he is describing. The trainee lightly supports his end of the frame and follows the instructor's movements. With the frame in proper adjustment it is readily apparent that both men look at the same object. By slowly moving the frame, the instructor can trace out creek bottoms, ridges, etc., and the two men can carry on a conversation at the same time.

For checking a lookout's knowledge of the country, the procedure is reversed. As an example, the ranger may ask the lookout to trace out the ridge between Lake Creek and Eagle Creek. The lookout then controls the movement of the frame and the ranger follows his movements.

This training aid is a good supplement to the map and fire finder, and has the following advantages: (1) It can be made in any shop in a very short time, using materials on hand; (2) it is especially useful in pointing out difficult terrain; and (3) it is a time saver.

Air Force Fights Fire on Tonto Forest.—The advantage of airborne attack forces was brought home to the Tonto National Forest on the Lewis Creek fire in June. The fire was discovered under the Tonto Rim about 2 p. m. on a Saturday afternoon, the opening date of the fishing season, a time when it is very difficult to secure local help. Shortly after 3 p. m. it was determined that adequate local help was not available, and a call was made to Williams Field, approximately 130 miles away. Men were assembled, flown to Payson Airport, and hauled 20 miles by truck, all within a period of less than 3 hours.

Twenty-five arrived in the first crew, all in one plane. They were young, husky individuals, willing to work; in fact, anxious to do so. Two of them were assigned to kitchen detail, and were most unhappy because they were prevented from fighting fire. An experienced crew boss was assigned to each five men. The men were held for approximately 24 hours, on the fire line over half the time. Then another crew of 25 was flown in and the first group returned to Williams Field. These men arrived on the fire in less than 3 hours, and after the first call could have been gotten there in less than 2 hours. It would have required at least 12 hours to secure men by truck from any other outside source.

This splendid cooperation resulted from a "memorandum of understanding" which was developed several years ago between the 3525 Pilot Training Wing at Williams Air Force Base and the Tonto National Forest for emergency use. The agreement provides for furnishing from 25 to 200 men by the Air Force, including transportation, suitable clothing, rations, and kitchen and mess equipment, as well as drinking water facilities and medical attention, and goes into some detail as to the procedure of assembling the men. They are recruited on a voluntary basis. We were told by the officers in charge that not the least difficulty was experienced in securing men. They said at least 200 would have volunteered, and they were anxious to come. This was borne out by the attitude of the men on the job, who really seemed to enjoy working on the fire, in spite of the fact that it was difficult and arduous labor. The businesslike and courteous attitude of the men generally was a source of much faborable comment by those who had an opportunity to work with and observe them.

The prompt and efficient action of the Williams Air Force Base undoubtedly averted a serious fire which would have caused great damage to an important recreation area and other national forest resources—Perl Charles, *assistant supervisor, Tonto National Forest.*

USE OF LIGHT PUMPERS AND AIRPLANES ON THE SUPERIOR NATIONAL FOREST

WILLIAM J. EMERSON

Superintendent, Ely Service Center, Superior National Forest

For many years fire control in the Superior lake country of Minnesota was exteremely slow and difficult and meant many hours of canoe travel and cross-country packing before the fire was reached. The seaplane, however, together with improved lightweight pumper units and other portable equipment, has revolutionized fire control work in this very extensive area of high recreational values. Water bodies are so numerous, and roads so few, that in many sections all other control methods are considered very difficult or impossible. In fact the seaplane-portable pumper combination has been developed to a point of such efficiency that it is used in initial attack on all fires not readily accessible by motor vehicle, and the portable pumper is a primary tool for mop-up. Even on many fires along roads, it is frequently possible to get quicker action by dispatching a plane pumper outfit from the seaplane base at Ely to a lake near the fire.

Because of existing roadless-area laws and the fact that roads are extremely difficult and costly to build, there will always be many extensive sections where motor vehicles may not be used. Fortunately, this Superior country is blessed with numerous lakes on which seaplanes may land (fig. 1).

The lake shores and islands of the Superior lake country are its areas of greatest fire risk, and the high percentage of fire occurrence in such spots makes the seaplane-pumper combination extremely effective. Every year many shore fires start in the lake country (usually from camp fires), and it is a common experience to suppress such fires with only 100 or 200 feet of hose, quickly landed from a Forest Service plane.

The basic equipment maintained by the Forest Service at the Ely Service Center and Ely Seaplane Base consists of 3 seaplanes and 20 portable pumpers complete with accessories and linen hose. The heavy fire suppression and other transport work is done by the 550-horsepower Noorduyn-Norseman, which can carry as many as five pumper-hose units complete with gasoline and accessories (fig. 2). Or it can transport two or three complete units with pumper operator and hoseman for each unit. Eight fire fighters with personal effects can be carried in the Norseman besides the pilot. The two lighter planes, a 165-horsepower Stinson station wagon and 65-horsepower Piper Cub, are used primarily for detection patrol over the roadless areas and for scouting and mapping work on going fires. All three planes are float-equipped.

Recently the Superior has been experimenting with new smaller and lighter pumpers that can be carried to small fires in the two lighter patrol planes. Of particular interest is the new Pacific Marine light-

FIGURE 1.—Superior roadless area.

eight "A" pumper which weighs only 36 pounds and is small enough o be carried in the four-place Stinson patrol plane with a two-man umper crew besides the pilot (fig. 3). A kit, made up to accompany his new pumper, consists of lightweight accessories, 1-inch linen hose n knapsack, small suction hose, and enough mixed gasoline to supply he pumper for the ordinary small shore fire. Small ax, pulaski, and ady shovel complete the kit. The entire pumper unit with hose and ccessories weighs only 100 pounds. Use of the smaller plane enables he small initial attack pumper crew to land on many small lakes where he large Norseman plane could not safely land or take off.

The new, lightweight pumper has been in trial use only part of one eason and little is yet known about its performance on the Superior, articularly in the many places where the vertical lift from the lake hore to the head of the fire is rather great. On one of the few fires here it was tried during the fall of 1949, the rough, rocky nature of he shore line prevented the seaplane from getting in close. The fire as close to the shore, so the pumper was set up on the float of the plane nd the two-man hose crew swam to shore with the light hose. With he seaplane pilot operating the pumper, the crew knocked the fire own with direct water attack before it could get a good start.

Most of the fires which start in this area originate from campfires or ghtning and usually require only one pumper unit to be suppressed. However, anywhere from 1 to 10 or even 20 pumper units may be ispatched, depending on information furnished the dispatcher by the atrol plane observer discovering the fire and by subsequent aerial couting. A short-wave FM radio network, with radios in each plane nd tower, portable radios on the ground, and a central control set in

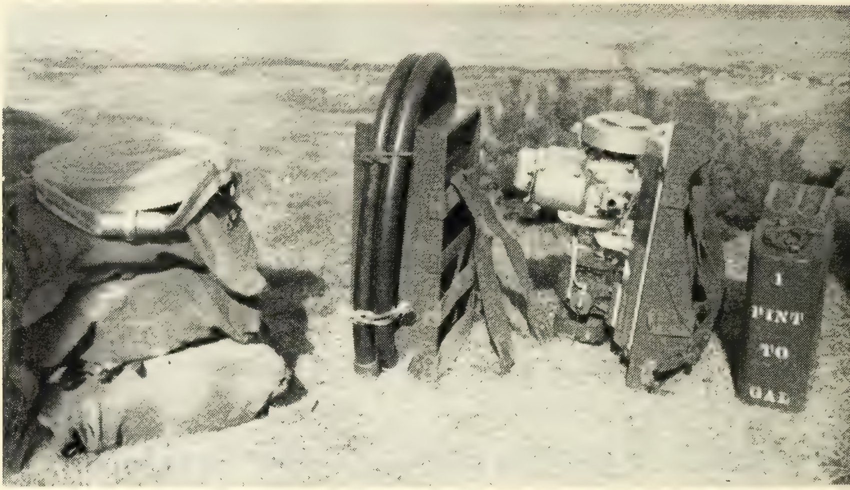


FIGURE 2.—A typical airplane pumper unit on the Superior: Pumper on pac frame, accessory box with intake hose, mixed gasoline, and 1,500 feet of $1\frac{1}{2}$-inc linen hose. This unit is usually transported in the Norseman seaplane with 4- or 5-man crew for fighting fires in the lake country.

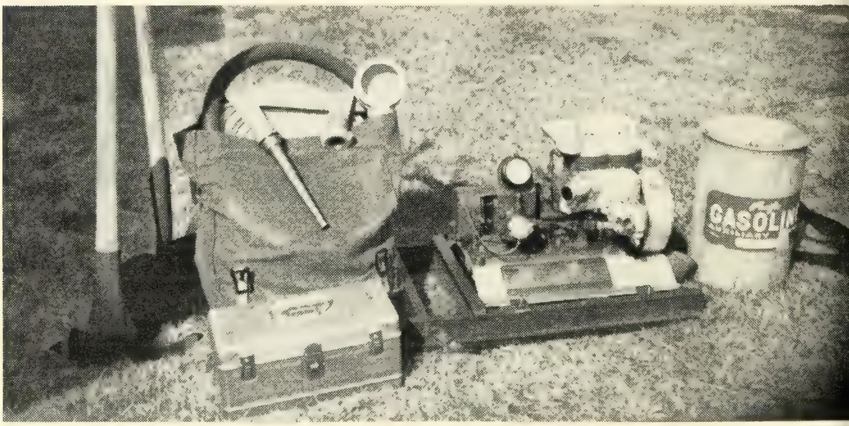


FIGURE 3.—Components of the 100-pound fire kit. Pumper is the new Pacifi Marine "A" weighing 36 pounds, mounted on pack frame. This can be operate on shore and island fires in the Superior wilderness country by two men. Thes two men, the pilot, and the 100-pound kit make up the pay load for the four place Stinson seaplane.

dispatcher's headquarters, gives excellent communication in this vas forest-lake area. Thus pumper units may be moved from one fire t another without returning to headquarters for instructions.

During peak periods of hazard and risk, small pumper units wit two- or three-man crews are sent along on detection patrol flights, s that direct attack may be made on any fire discovered. With this sys- tem, fires may be attacked by the small pumper crew only minutes afte being discovered by the patrol plane, thereby saving much time and th resultant larger force required by a larger fire.

The new pumpers are also very practicable where the fire suppression
quipment must be packed long distances across country. Their com-
actness and light weight are a vast improvement in this area over the
lder, heavier portable pumpers, and the small hose and accessories add
) the improvement. Two men can pack a complete "A" pumper-
ose outfit plus a couple of hand tools apiece for some distance cross
ountry without experiencing severe exhaustion upon arrival at the
re. Here again, Forest Service airplanes frequently make the differ-
nce between success and failure on the control job. As soon as a fire
discovered, the dispatcher is able to determine the amount of hose
eeded by having the plane locate the nearest water chance and esti-
ate its distance from the fire. The direction and distance from the
re and other description of this water chance is provided the pumper
oreman so he takes enough hose, but not too much, which would tax
nnecessarily the carrying power and speed of the crew going to the
re across country.

On many of these back-country fires, water chances may be available
hat do not show up on the map. Very small pot holes, wet swamps,
itermittent streams, etc., provide enough water hose for fires in many
laces. During spring and fall, and during wet summers, there have
een instances where the only water close to the fire was that lying in
low spot in an old winter logging road. The trained aerial observer
often able to spot such water chances, thereby giving the disptacher
nd pumper foreman invaluable information shortly after the fire
discovered.

The air observer, by means of FM handy-talkies, is able to direct
he pumper crew to the fire or water chance, or both. One member
f the crew carries the handy-talkie, while his partner carries a bright
range flag. The air observer cruises overhead, following the course
f the crew toward the fire by sighting the orange flag waved period-
cally by the crewman. Every few minutes, the handy-talkie oper-
tor pauses and calls the observer, who gives him new estimated bear-
ng and distance to the fire from his present position. Thus, the fire
rew is "talked in" to the fire, sometimes saving them miles of need-
ss wandering en route, and much valuable time.

Many lightning fires on the Superior start in snags or large trees
i areas where dirt is practically absent, the soil types being muskeg
wamp and solid rock. The small lightweight portable pumper is the
est tool for these fires, but the problem lies in finding the burning snag
r tree without carrying the portable pumper many needless miles
uring the search. Here the plane-to-ground radio directions are in-
aluable, and several times the crew has been "talked in" over long
istances to a single burning tree or snag by means of the handy-
alkie and bright flag. Similarly the crew may be directed to the
est and nearest water chance discernible from the plane. Inci-
entally, this system is beginning to be used effectively in locating spot
res on large fires.

In addition to the Pacific Marine "A" and "Y" portable pumpers in
se on the Superior, another quite satisfactory portable pumper has
een made available by remodeling work in the pumper repair shop at
he Ely Service Center. A Pacific Marine "N" pumper has been con-
erted to one called the "AN" locally by cutting off two of the four
ylinders and shortening the shaft and pumper length several inches.
atisfactory performance for most chances is obtained and the im-

provement in weight and portability is an advantage, especially o back-country fires and fires handled by boat and canoe transportatio

The Superior National Forest is currently experimenting with var ous lightweight accessories and supplemental equipment to enabl portable pumper fire crews to get to fires quicker and easier, and t move their equipment faster and with less difficulty from one point t another on a fire.

One of the recent developments being tested is the new Harodit canvas relay tank or "dike" (fig 4). This is a heavy, treated canva

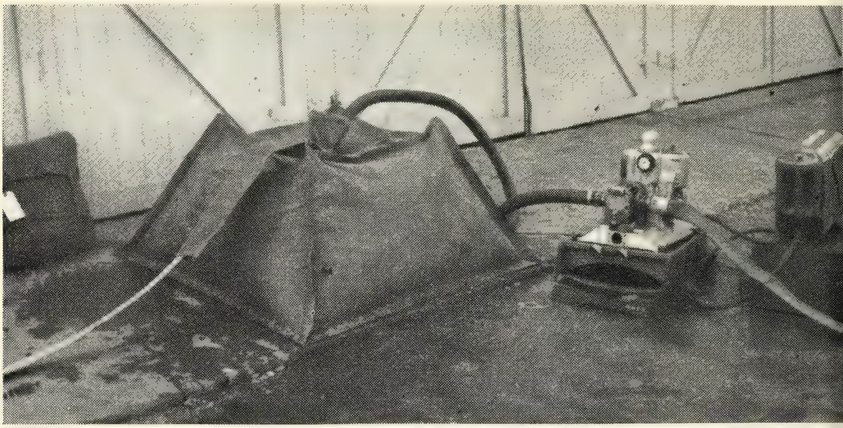


FIGURE 4.—Typical relay set-up: Canvas relay tank, 150-gallon capacity, pumpe and special gas can. Knapsack at extreme left contains a 300-gallon canva relay tank folded up for transporting to a fire.

tank, pyramid-shaped with intake and output vents in the top. Th Superior now has, for trial use, a 150-gallon tank and a 300-gallo tank. In a tank of this shape, the water supports the canvas structur without any additional legs or other supports. These canvas rela tanks are very portable, folding to a flat bundle about 1½ feet squar which may be easily carried in a small packsack. Thus the severa pumper relay tanks needed in a very long or steep hose lay could b readily carried in packsacks by a couple of men.

Fires in the Superior border-lake country usually occur in midsum mer, when the very deep duff dries out and provides a ready avenue o travel for the fire down deep among the rocks. Here resistance to co trol frequently reaches extreme proportions. A large fire in this are is a very costly, back-breaking operation, extending over a long perio of control and mop-up. The portable pumper-seaplane combinatio seems to be the answer to the question of how to keep most fires sma to avoid disastrous and expensive project fires in this extensive are which is otherwise so inaccessible.

USE YOUR WEATHER RECORDS TO INTERPRET FIRE-WEATHER FORECASTS

Owen P. Cramer

Meteorologist, Pacific Northwest Forest and Range Experiment Station

"The weather man missed it!" You've probably made that kind of statement about a fire-weather forecast yourself.

What actually happened though, might well be described like this: "The area forecast was not interpreted in terms of the topographic and cover effects at the particular point for which it was used." You can understand why such a description is more accurate by thinking about the nature of fire-weather forecasts and how topography and cover in your district might affect the weather.

The routine fire-weather forecast is an area forecast. Among other things, it describes the general conditions of air flow and the temperature, humidity, and other properties of the air mass the forecaster expects to be present over a large area, say 3,000 to 5,000 square miles. A typical western forecast area has more or less mountainous terrain with cover varying from rocky barrens to old-growth forests. The difference in elevation from the valley floor to the summits may be as much as 5,000 feet—sometimes even more. Within such an area the weather at any one time will be influenced by many local conditions. Heating of air on sunlit south slopes results in up-slope wind currents; the cooling of air on shaded north slopes produces down-slope currents. The air may be funneled through a canyon, or deflected by a ridge lying at right angles to the wind. Friction slows the movement of air over an old-growth forest, and venturi action accelerates wind blowing through a saddle. Eddy currents form in the lea of a mountain.

Suppose then, the forecast tells you that the air will be moving over such an area at 15 to 20 miles per hour from the northwest and that the minimum humidity of that air will be 30 to 35 percent. It would be illogical to expect all weather observations made within the area to be within these narrow limits. Then how can the forecast be used? Your weather station records can provide the means.

For example, take the typical western area mentioned earlier. Undoubtedly forecasters have been predicting northwest winds of 15 to 20 miles per hour for this hypothetical forest from time to time for many years. Each time that the motion of air across the area was described by the northwest 15 to 20 forecast, the topography probably affected air movement in the same way, reproducing a relatively fixed pattern of eddy currents and other changes over the area. At a particular fire-danger station within the area it is likely that local winds will differ from the forecast in the same way each time this general wind condition exists. At a second station within the area, a still

different wind will be observed with the same general flow. Some exposed anemometers in open areas or at stations on high peaks where the flow is little distorted may observe the forecast wind. Now by determining, for selected fire-danger stations within the area, the most likely local wind for any general wind given in the area forecast, you could readily interpret the wind forecasts.

This "most likely" wind may be found by analyzing the fire-weather forecasts made during past years for the area and comparing them with the weather observations made at the selected stations during the same period. For each station make a tally of the winds observed for each general wind forecast (table 1). The tally will show in most cases the station wind that is most likely to be observed for each direction and speed of the wind described in the fire-weather area forecast. Such an aid may be developed for estimating a fire-danger station's wind at the peak of the day's burning conditions from either a morning or the previous evening forecast for the day.

TABLE 1.—*Observed wind speeds for a mountain station in Oregon at time of highest daily fire danger by forecast wind direction*[1] *and speed class*

Forecast wind direction and speed in miles per hour	Observed wind speed							
	0–3 m.p.h.	4–6 m.p.h.	7–9 m.p.h.	10–12 m.p.h.	13–15 m.p.h.	16–18 m.p.h.	Over 18 m.p.h.	Predominant
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*M.p.h.*
S.:								
10–12	------	------	------	3	1	1	------	10–12
16–18	------	------	------	1	------	------	------	------
SW.:								
10–12	------	3	7	1	------	2	------	7–9
13–15	------	------	2	4	3	1	------	10–12
16–18	------	------	1	------	------	------	2	------
Over 18	------	------	------	------	------	2	------	------
W.:								
7–9	1	5	3	------	3	------	1	[2] 7–9
10–12	------	1	9	8	1	1	1	7–9
13–15	------	5	17	6	3	1	------	7–9
16–18	------	4	5	------	------	1	1	7–9
NW.:								
7–9	1	3	4	4	2	2	------	[2] 7–9
10–12	1	4	12	------	3	------	1	7–9
13–15	1	6	1	3	2	------	------	7–9
16–18	------	1	2	3	1	------	------	[2] 7–9

[1] Because of space limits, only four directions are shown.
[2] The limited number of observations used in this case does not result in a clearly predominant speed; could be 10–12.

You can apply the same method to observed rather than forecast winds. For example, using winds observed in the morning at exposed peak stations, you will find that for each such observed wind a certain wind will occur most frequently at the usual time of greatest fire danger later in the day. This information can be mighty handy when one morning you find that the wind at peak stations has shifted

and increased from the wind of previous days. You wonder: Just what afternoon wind does this morning wind indicate? The station weather records of past seasons can help greatly in making a useful prediction.

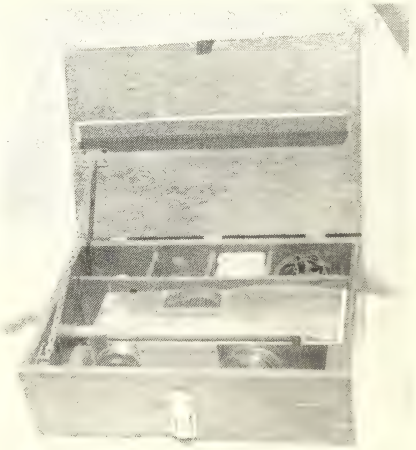
In the Pacific Northwest, we have found that similar methods also apply when interpreting the predicted minimum relative humidity in terms of the fuel-moisture reading to be expected on indicator sticks. Each station is different, however, and to date it appears that, as with the wind, this forecast-interpretation aid must be prepared individually for each station.

Such aids to interpretation of forecasts are of course not perfect. The forecast is only the best available estimate and shouldn't be expected to be exactly correct every time. Some variation in local effects will occur with similar but slightly different general weather patterns. There will also be occasional periods of exceptional weather. You may sometimes be able to identify these periods as expected distinct exceptions to the rule. Lastly, because of differences in station exposure, the reliability of the aids will vary from station to station. Nevertheless, such aids can give considerable help in estimating burning conditions in advance at individual fire-danger stations.

Successful aids of these types have been constructed for many Forest Service fire-danger stations in Region 6. The process of construction itself has added greatly to the understanding of local weather peculiarities. Laboratory test and field use of the aids have consistently resulted in more accurate numerical estimates of expected forest fire danger.

Protective Carrying Case for FM Handie-Talkie Radio.—In 1949 we had some difficulty in carrying our handie-talkie radios in pickups and jeeps without considerable danger of damage. A leather case was constructed, but it was not sufficiently rigid to fully protect the unit. Therefore, a protective plywood carrying case was devised.

The case is made of one-half-inch Douglas-fir plywood with one-quarter-inch plywood partitions enclosing space for two sets of extra batteries and airplane antenna. The radio is held firmly in place and is supported entirely by sponge rubber. The case is finished with one coat of shellac and two coats of spar varnish. The carrying handle was placed on top of the case rather than on the edge to encourage hauling it in a flat position so that it would not tip over. The lid is fastened with an eccentric hasp-type catch so that it may be locked with a padlock. Materials cost just under $5.



Plans of this carrying case may be obtained from the Supervisor's Office, Harney National Forest, Custer, S. Dak., if desired.—Hugh E. Martin, *assistant supervisor, Harney National Forest.*

NORTHEASTERN INTERSTATE FOREST FIRE PROTECTION COMPACT

R. M. Evans

Executive Secretary, Northeastern Forest Fire Protection Commission

For nearly everyone who will read this article, the disastrous Maine fires of October 1947 have been effectively dramatized by the short motion picture "Then It Happened." The picture is vivid enough, but to have viewed the conflagration from the air while it was in progress, and later the devastated woodlands and farmsteads and villages, was an experience which the writer will not forget.

Fortunately, some good came from all the damage and destruction. First, Maine enacted long-needed legislation to center in the forest commissioner authority over forest fire fighting activities in organized towns, and, second, the Northeastern Interstate Forest Fire Protection Compact came into being.

The Compact didn't just happen over night. Instead, the idea was hammered out in months of discussions which began in the Conference of New England Governors held shortly after the fires. Chief credit for the result goes to a committee composed of the New England and New York State foresters, to which the late John W. Plaisted, of the Massachusetts Commission on Interstate Cooperation, was advisor; to Frederick L. Zimmerman, research director of the New York Joint Legislative Committee on Interstate Cooperation, who prepared the draft; and to the New York office of the Council of State Governments for its guidance and assistance in presenting the Compact to Congress and the State legislatures. It is worthy of mention that representatives of the United States Forest Service participated in the discussions at all times.

Congress passed enabling legislation and six of the seven States ratified the Compact in 1949, the seventh State ratified early in 1950. As far as is known, this sets a record for speed in adopting an act of this kind.

The Compact is quite a document. It is open-ended territorially; that is, any contiguous state or province of Canada may become party to it. It is hoped that the Provinces of Quebec and New Brunswick will join.

The language of the Compact is broad enough to encompass the whole field of forest fire prevention and suppression in the seven States. For example, article I states:

> The purpose of this compact is to promote effective prevention and control of forest fires in the northeastern region of the United States and adjacent areas in Canada by the development of integrated forest fire plans, by maintenance of adequate forest fire fighting services by the member states, by providing for mutual aid in fighting forest fires among the states of the region and for procedures that will facilitate such aid, and by the establishment of a central agency to coordinate the services of member states and perform such common services as member states may deem desirable.

The Compact creates the Northeastern Forest Fire Protection Com-
ission, composed of three members from each State, one of whom
hall be the state forester, one a State legislator designated by the
ommittee on interstate cooperation of that State, and one "shall be
person designated by the governor as the responsible representative
f the governor."

The commission was organized at a meeting in Boston on January
9, 1950. Perry H. Merrill, State forester of Vermont, was elected
hairman and Arthur S. Hopkins, director of lands and forests, New
'ork, was elected vice chairman. Early in May 1950, the writer was
ppointed executive secretary. An office has been established in the
'orestry Building, Laconia, N. H.

The Compact empowers the commission "to make inquiry and
scertain such methods, practices, circumstances and conditions as
ay be disclosed for bringing about the prevention and control of
orest fires, to coordinate the forest fire plans and the work of the
ppropriate agencies of the member states, and to facilitate the ren-
ering of aid by the member states to each other in fighting forest
res." The commission has the power to recommend to the signatory
tates any and all measures, legislative or administrative, that will
ffectuate the prevention and control of forest fires. An important
rovision empowers the commission to formulate and revise a regional
re plan for the entire region covered by the Compact, which will
erve as a common forest fire plan for that area. Furthermore, the
ommission may request the United States Forest Service to act as
e primary research and coordinating agency and the Forest Service
ay accept the initial responsibility in presenting to the commission
s recommendations with respect to the regional fire plan.

The Compact obligates each State to formulate and put into effect
forest fire plan and to take such measures as may be recommended
y the commission to integrate its plan with the regional forest fire
lan. In emergencies, each State is obligated to render aid to other
ember States consistent with the maintenance of protection at home.

The Compact solves the difficult problems connected with powers,
mmunities, liabilities, and duties of State forces rendering aid to
nother State. It provides that the employees of an aiding State
hall, under the direction of the officers of the aided State "have the
me powers (except the power of arrest), duties, rights, privileges and
mmunities as comparable employees of the state to which they are
ndering aid."

As to liability, it is provided that no State or its officers or employees
ndering outside aid under the Compact shall be liable on account of
y act or ommission on their part, or on account of the maintenance
d use of any supplies in connection with their mission; and that all
ability which may arise, under the laws of either the requesting or
e aiding State, or under those of a third State, or in connection with
request for aid, shall be assumed by the requesting State. The aiding
tate shall be reimbursed by the receiving State for any loss or damage
curred in the operation of any equipment answering a request for
d and for the cost of all "materials, transportation, wages, salaries
d maintenance of employees and equipment incurred in connection
ith such request." However, the Compact provides that the aiding
tate *may* assume loss, damage, or expense, and may donate services.
was thought that in the case of limited aid donation would be the

probable practice, but that in the case of major losses and services i was only fair that the requesting State should be liable for the costs On the other hand, the Compact provides that each member State shal provide for the payment of compensation and death benefits in cas its employees sustain injuries or are killed while rendering outside ai pursuant to the Compact in the same manner and on the same term as if the injury or death were sustained within the State. To avoi questions of liability which might arise with respect to voluntee forces, the Compact provides that "the term employee shall includ any volunteer or auxiliary legally included within the forest fir fighting forces of the aiding state under the laws thereof."

Although it is not expected that the costs of maintaining the com mission will be great, provision was made by the Compact fo standards in the allocation of any appropriations that may be neces sary. It directs the commission to allocate the cost among the State affected "with consideration of the amounts of forested lands in thos states that will receive protection from the service to be rendered an the extent of the forest fire problem involved in each state." Th commission is instructed to submit its recommendations, based on thos considerations, to the legislatures of the affected States.

The foregoing are some of the important provisions of the Compac There are others.

The policies, plans, and work of the commission still are in the form ative state. The Compact was conceived as a means of providin mutual aid in the event of disasters such as the Maine fires of 194 Provision is being made for that through comprehensive State fir plans prepared from a standard outline, and a regional plan i accordance with which the Laconia office will act as collector and dis tributor of information about the fire situation in the several State and as dispatcher in case interstate aid is needed.

But it is believed that the commission's greatest usefulness will b in a general leveling up of competence in the forest fire control fiel among the member States through such things as the sharing of idea training, strengthened legislation, standardization of equipment, an public education. Already closure laws are being studied to see if the may be made more flexible and uniform. The possibility of developin a closure index is being investigated. Uniform training outlines fo overhead personnel will be developed and training on an area basi will be stepped up. The place of State forest fire organizations i State civil defense set-ups is being looked into.

All in all, it is the feeling that the Compact provides these seve States with the opportunity to develop an example of unified actio in a given field that might well become a model for similar actio elsewhere.

ume 12 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

TED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1951

CONTENTS

1949 FIRES AND TRENDS OF FIRE OCCURRENCE IN THE NORTHEAST

A. W. Lindenmuth, Jr.

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n 1949, 10,858 fires were reported to have burned on State-protected l national forest land in the Northeast.[1] This was a 42-percent increase r 1948. Was the increase caused by a larger number of fire starters, a lown in fire-prevention efforts, a more severe fire season, or a combin- on of all three? An analysis of fire-danger measurements and fire records vides some good clues.

Ve know that about 99 percent of the fires starting in this region are ised by man. Hence, the number of fires depends chiefly upon two tors, risk and flammability. Risk, or the probability of someone or some- ig causing a fire, can be controlled by fire-prevention efforts but cannot measured directly. Flammability, on the other hand, cannot be con- lled but can be measured quite accurately. Burning index in the North- t is a measure of flammability.

n order to separate the effects of risk and flammability (burning index), nethod of rating the severity of fire seasons, reported in a previous icle,[2] is used. Briefly, the number of expected fires is calculated from cumulated burning indexes as reported from the fire-danger stations, ıming for purposes of the calculation that an unchanging risk prevails. en the expected and the actual number of fires are plotted for a number years.

To show this, data from all northeastern national forests and States, epting Delaware (for which information is not available), are graphed igure 1. It is evident that both the number of actual and expected fires k a sharp upswing in 1949. The trends are not exactly the same but amount of divergence is small—1949 ratio 1.03, 1948 ratio 0.95. For region as a whole, the risk was almost the same in 1949 as it was in 8, and it can therefore be concluded that the difference in the number ires between the years was caused by weather conditions.

n graph B, figure 1, the ratios plotted for the past 7 years indicate a vnward trend, even though there are humps and dips from year to r and there is a slight upswing in 1949. Statistically, the odds are about to 1 that this is a real trend. While these odds are relatively small, they

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[1] Only fires that occurred on days when fire-danger measurements were made are uded.

[2] Lindenmuth, A. W., Jr., *and* Keetch, J. J. a new measure of the severity fire seasons. U. S. Forest Serv. Fire Control Notes 11(1): 15-19, illus.

are supported by the fact that fire prevention efforts are being intensi each year. It is reasonable to suppose that in this region the annual penditure of, roughly, 3 million dollars for prevention is accomplish something.

We can't assume that the over-all downward trend necessarily app to individual States or national forests. This is evident from the data table 1.

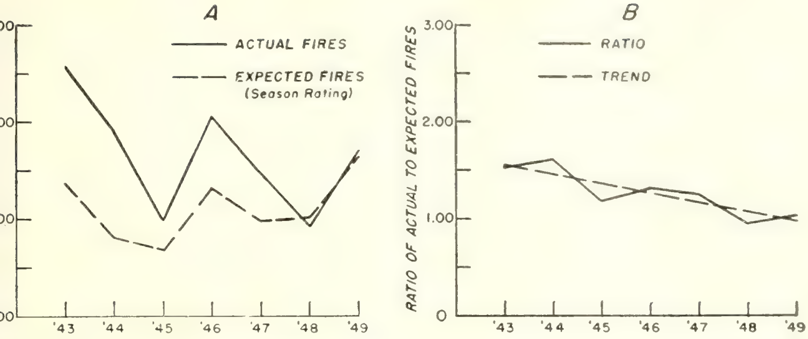
One major comparison that can be made within the region is betw States and national forests. The State job is to prevent fires on priva owned lands on which the protection agency has relatively little con over the fire risk. On the other hand, the U. S. Forest Service is chi concerned with reducing the number of fires on Federally owned lan where it has considerable control over risk (timber sale agreements, car fire and hunting permits, etc.).

Despite this difference, we find that the ratios for the two groups about the same during 1949 (1.03 for the States and 0.90 for the natio forests) as, in fact, they have been for the last few years. This simila

TABLE 1.—*Fire occurrence and season ratings, by national forests States, Northeastern Region,* 1949

Unit	Fires		Ratio of ac to expected
	Actual[1]	Expected	
National Forest:	*Number*	*Number*	
Allegheny	23	21	1.10
Cumberland	72	88	0.82
George Washington	39	41	0.95
Green Mountain	4	2	2.00
Jefferson	37	38	0.97
Monongahela	25	36	0.69
White Mountain	7	4	1.75
Total or ratio	207	230	0.90
State:			
Connecticut	435	933	0.47
Kentucky (Kentenia-Redbird Dist.)	30	22	1.36
Maine	677	380	1.78
Maryland	381	622	0.61
Massachusetts	1,616	1,296	1.25
New Hampshire	527	377	1.40
New Jersey	1,465	1,336	1.10
New York:			
Adirondacks District	424	237	1.79
Long Island District	150	251	0.60
Pennsylvania	1,495	1,665	0.90
Rhode Island	303	204	1.49
Vermont	173	107	1.62
Virginia	1,601	1,787	0.90
West Virginia (30 counties)	1,374	1,110	1.24
Total or ratio	10,651	10,327	1.03
Region total or ratio	10,858	10,557	1.03

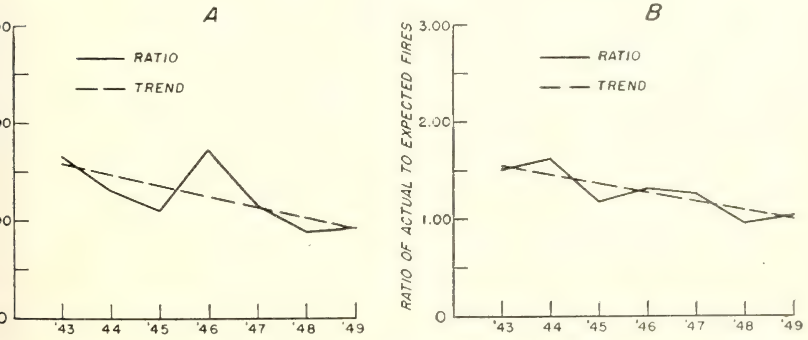
[1] Only fires that occurred on days when fire-danger measurements were made included.



URE 1.—*A,* In the northeastern region the 42-percent increase in number of fires 1949 over 1948 was due almost entirely to a similar increase in the severity of e fire season. *B,* Irrespective of the slight upswing in 1949, the over-all trend the ratio of fire occurrence in the Northeast is downward.

accomplishment is shown graphically in figure 2. Both groups have n successful in reducing the number of fires and one group has done ut as well as the other, since the downward trend for each group has ut the same slope. The national-forest data are the more erratic be-se the number of fires occurring in any year is relatively small; for some sts a few fires more or less can markedly affect the ratio.

)f more importance, perhaps, are the trends indicating either increases notable decreases in the fire-occurrence ratio. Increases point to a ater risk not effectively controlled by prevention efforts. Notable de-ises in the number of fires mean that the risk is less either because ewer fire-starting agents or because the activity of the causal agencies been curbed by an effective prevention program. A knowledge of these ids should enable administrators to search for a change in the risk ern, or—in the case of improvement—to evaluate and distinguish the isures that are paying off.



URE 2.—*A,* Records from the national forests in the northeastern region show an ver-all decrease in the fire-occurrence ratio within the national forests. *B,* Records om all States in the Northeast, except Delaware, show that the ratio of fire ccurrence is decreasing on private lands to about the same degree as within the ational forests.

Increases in fire-occurrence ratio seem to be more prevalent in northern part of the region, as attested by the relatively high ratios (table associated with many of the units from the Adirondacks eastward. P ticularly among the northernmost units, Maine, New Hampshire, Vermo and the Green Mountain and White Mountain National Forests, number of fires has been at a high level for several years and the over- trend is upward. This situation is evident in figure 3. Except for the e years of 1943 and 1945, the number of fires has been much greater

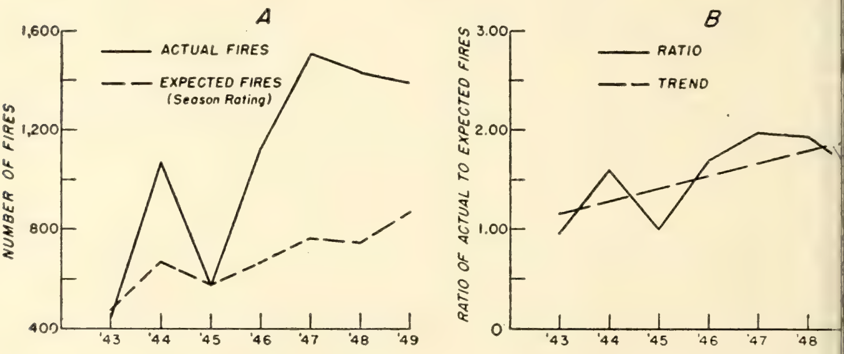
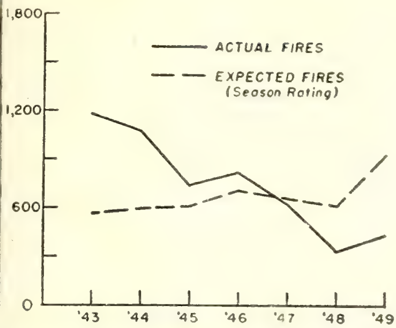


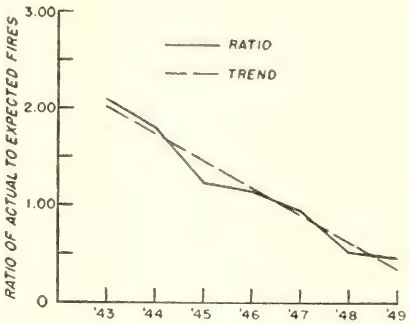
FIGURE 3.—*A*, The number of fires occurring within the northernmost group States and national forests of the northeastern region has been high for sev years. *B*, Because of this large number of fires, the over-all trend of the ratio of occurrence is upward in this section of the region.

proportion to the cumulative burning index than expected. Howev there is evidence that the upward trend, attributable chiefly to the unu ally large number of fires during 1944, 1946, and 1947, has been rever during 1948 and 1949. It is too soon to be certain, but the reduction the ratio of actual to expected number of fires was common in 1949 all States in New England, except Rhode Island. Maine, which forme had the highest ratio in New England, made the greatest reductio from 2.58 in 1948 to 1.78 in 1949. All these changes occurred despite increase in the severity of burning conditions in northern New England

A notable decrease in fire-occurrence ratio took place in Connectic This outstanding record is closely followed by that of Maryland and Monongahela National Forest, in that order. In Connecticut the ra of actual to expected number of fires decreased steadily year by year fr 1943 through 1949 (figure 4). The decreases have been so uniform a so sustained that they are almost certainly the result of a planned p gram—the odds being about 200 to 1 that this did not happen by chan Had the downward trend been caused by a smaller number of fire-start agents each year, the results would not have been so uniform. At a rate, there is no evidence to indicate that the number of picnick hunters, debris burners, etc., decreased in this State while they increa in nearby States. Fire-prevention measures apparently are responsible changing the habits of the persons who have been causing the fires.

The year 1949, then, in the Northeast was a bad year when gag solely by the number of fires that occurred. But valid conclusions cann





IGURE 4.—Accomplishments in Connecticut are an example of a notable reduction in the ratio of fire occurrence.

e based on that fact alone. The cumulative burning index for the year ndicates that more fires could have been expected during 1949 than n any other year since danger measurements have been made. Region-ide, the evidence indicates that the fire-control organizations handled bad year without losing ground—with gains just about balancing the osses. When allowance is made for the year's weather, it is clear that ne trend toward increased efficiency is continuing.

Heating and Ignition of Small Wood Cylinders

This is the title of an article by Wallace L. Fons published in the October 1950 sue of "Industrial and Engineering Chemistry." A small supply of reprints has een requested for distribution to those interested in the technical details. The work ported in the paper is a part of the more fundamental fire research being carried it at the California Forest and Range Experiment Station at Berkeley.

Although the paper may seem highly technical to the average fire man, it may ive considerable significance to future improvements in fire fighting methods. The iper describes the use of an electric furnace with thermocouples and photoelectric otentiometers to measure and record the surface and interior temperatures of ood cylinders up to the time they ignite.

From the tests made, it was found that surface ignition temperature of 650° F. as most significant for twigs and branch wood. This was found to be the minimum mperature at which flames would appear when rapid heating took place. But if irt of the material was first reduced to charcoal, it would glow at temperatures low as 450°. Charred materials thus ignite easier than most other fuels. In fire ghting, fuels must, for the same reason, be cooled to temperatures below 450° to certain the fire will not rekindle.

The tests demonstrated that ignition slowed up significantly as size of the stick creased even in the diameter range of ⅛ to ⅜ inch used, so long as the temperature which the sticks were exposed was between 800° and 1000° F. At 900° the range time was from 20 to 44 seconds. At temperatures of 1300° or more, all sizes used irst into flame simultaneously in less than 5 seconds. This is highly significant to e behavior and illustrates the importance of the temperature and character of the ime front that builds up. These results were at very low moisture contents. Moisture the wood also slowed up ignition decisively. This effect was more pronounced than ould be accounted for by specific heat of the water alone.

The temperature of the wood itself in the range of 50° to 150° F. had relatively tle effect on the rate of ignition in the furnace tests.—A. A. BROWN, *Washington ffice, U. S., Forest Service.*

TEXAS CENTRALIZED RADIO DISPATCHING SYSTEM

E. R. Wagoner, *Assistant Forestry Educator,* and L. J. Beard, *Head Communications Sub-Section, Texas Forest Service*

During the winter of 1944 Texas was plagued with a freak ice storm that disrupted telephone communications throughout much of the Piney woods area of East Texas. Several hundred miles of Texas Forest Service telephone lines were made useless. An outbreak of fires following this storm would have caught Texas without a communications system.

Occurring as it did, during the critical days of World War II, the supply of both telephone and radio equipment was meager. In view of the emergency, however, the War Production Board authorized priorities to purchase a limited amount of radio equipment, but immediate deliveries could not be effected. Five used transmitters that had been operating on the 160-meter amateur band were modified and licensed to operate on 2226 kilocycles. As soon as available 30 commercial mobile receivers were purchased for mobile units.

Texas was the first southern State to make extensive use of aircraft in detecting forest fires. Twelve transceivers were installed in Civil Air Patrol aircraft. This early use of radios was considered a temporary measure as it was not planned, at that time, to replace the telephone equipment with radios. In fact, action was initiated toward moving telephone lines to more accessible locations along highways. The early use of radios sold Texas on the advantages of radios over telephones. The chief advantages were the economy of maintainance and the opportunity of maintaining constant communications with all mobile units.

Because of these advantages it was decided to build up a radio communication system around frequency modulated communications equipment.

Following World War II, the Texas Forest Service, a part of the A. & M. College System, felt that a task force, similar to that used in battle could be used effectively to suppress forest fires. In building such a force to fight fires it is imperative to have mobility of transportation and communication. With this mobility, any unit or aircraft could be transferred anywhere it was needed in the State, without disrupting communications.

In most southern States, dispatching responsibilities are broken down on a county or a part county basis. Texas, however, has one central radio dispatcher for an entire district which contains three to ten counties. The dispatcher operates the main station, handling traffic with mobile units in his district, and with main stations in other districts (fig. 1).

Before any main station equipment was purchased, engineering tests were made to determine the type of equipment best suited for forestry traffic in Texas. Engineering tests were run with four mobile units and a station house receiver. Frequency modulated equipment replaced ampli

IGURE 1.—Dispatcher O. H. Hill, District 3, Lufkin, and Texas Forest Service main station equipment for Radio Station KKB 849.

ide modulated. Five Texas Forest Service aircraft were equipped with rmy surplus sets.

In 1950 the Service offered 1,400 miles of standing telephone line for le. Funds derived from the sale of telephone equipment were used to urchase radios for lookout towers. It was found desirable to keep the ›wer traffic separate from the mobile unit traffic. To do this and avoid ogging one frequency, two tower frequencies were established. One or ıore towers in each district were designated as key towers. Other towers e called secondary towers. All towers communicate with each other, ossing out fires on 170.425 megacycles. Key tower traffic with main ations is on a frequency of 170.575 megacycles (fig. 2). After a fire crossed out, it is reported to the dispatcher through the key towers. rdinarily, the key towers are the only towers communicating with the spatcher. If for any reason, a key tower is not manned, the dispatcher as a dual frequency receiver which enables him to monitor all secondy tower traffic.

The dispatcher is the key individual in the district communication ganization. The mobile unit traffic, the aircraft traffic, and the tower affic are all directed to the dispatcher for appropriate action. Traffic ith cooperating organizations, such as the Texas National Forests, is so handled on 170.575 megacycles.

Radio equipment planned or in use for forestry traffic in Texas include:

One 250-watt base station at Fire Control Department headquarters.
Five 60-watt base stations at district headquarters.
Seventy 60-watt mobile units.
Five 10-watt mobile units converted for aircraft operation.

Two-thirds of the telephone line offered for sale has been sold. As funds become available from the sale of telephone equipment, radios are being purchased for tower installation. It is planned to equip 77 towers with radios to complete the radio communication system.

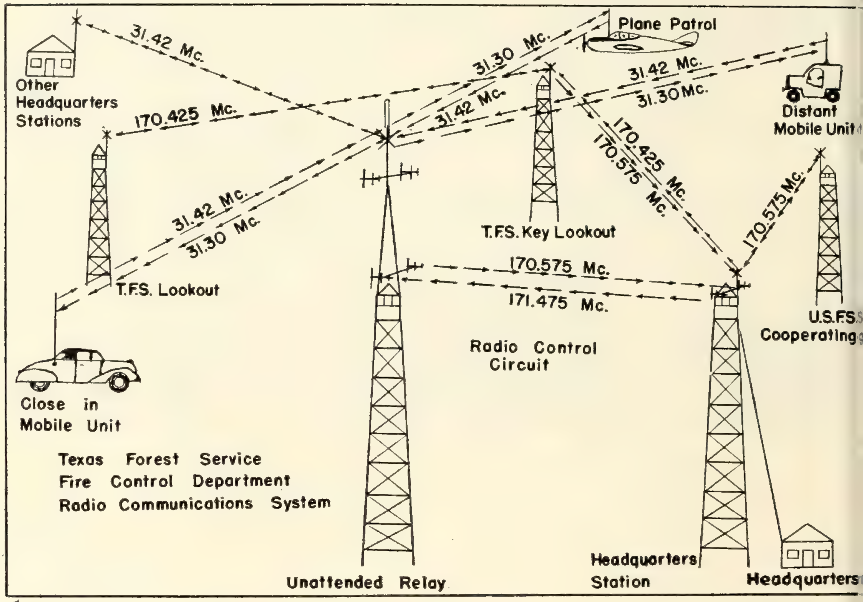


FIGURE 2.—Diagrammatic radio communications system.

Two of the administrative districts in Texas have peculiar shapes. The boundaries of these resemble a figure eight. For example, the distance across the district, that is north and south, is small compared to the distance from the extreme eastern point to the extreme western point in the district. It was difficult or impossible to communicate with mobile units in extreme corners of the districts. For this reason, it was found desirable to install bi-directional antenna at base stations in two districts. This fact alone makes Texas' communication system unique, since directional antenna are seldom used for forestry traffic.

One other district presents an unusual problem in that the district headquarters and base station are not situated at a central location in the district. This problem was solved by installing an unattended automatic relay at the highest point of elevation within the district. The unattended relay station is 18 air miles from the base station. Traffic is relayed to and from district headquarters through the unattended station. The unattended relay is equipped with a folded unipole and a six element beam antenna which is directed to the most remote corner

f the district. Each antenna has its associate receiver and is selected y tone signals for transmitting purposes.

The three other 60-watt base stations utilize the conventional unipole ntenna.

The Fire Control Department of the Texas Forest Service is organized round the district dispatcher to permit maximum speed of communicaon and transportation. It is intended that mobile units will be retained their own district. But in case of an extreme emergency, the Texas stem makes possible the transfer of fire suppression vehicles and aircraft quipped with two-way radios as a task force from one district to another ithout disruption of communication.

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(Continued on Page 13.)

EFFECTIVE SUPPRESSION BY A SMALL HORSE-MOUNTED FIRE CREW

Gilbert B. Doll

Assistant Supervisor, Toiyabe National Forest

The Jack's Springs fire started on July 1, 1950, and in the next thre days spread over 2,075 acres of noncommercial forest land. The area i which this fire occurred is semidesert characterized by steep canyon The predominate cover is pinyon-juniper and sagebrush. The soil is sandy Many dead logs and trees scattered through the green growth on th area caused considerable spotting and quite a roll problem. The sup pression job was mainly one of hot-spotting and fuel robbing.

Of particular significance in planning the suppression action was th inaccessibility of the fire. It was 10 miles airline from the nearest road head. The distance was not too important because we have often walke men farther and in more rugged country. Walking in the *loose sand* however, through broken country with temperatures in the 90's increase the fatigue factor so much that it was believed equal to that of more tha double the travel distance. For example, the first crew of nine me reached the fire nine hours after leaving their truck; the second crew o 18 men walked 12 hours after leaving the roadhead. They averaged les than a mile per hour travel time. The men were physically exhauste upon reaching the fire and the fact that they did some effective wor was mainly because they drove themselves to continued effort. Both crews had hospital cases due to heat exhaustion and sore feet. The failed to hold the fire and it made runs the afternoons of July 1 and 2

Aerial scouting and information obtained from other sources led to th decision that an entirely different plan of attack was necessary. We coul either: (1) Use smoke jumpers, not immediately available. (2) Use from fifty to one hundred men along the 12-mile fire perimeter, hold crews i relatively small working areas, and subsist and bed down right on th line in order to decrease the walking fatigue factor. (3) Use a small well-trained crew of horse-mounted fire fighters.

Considering values, costs, distances, and other factors it was decide to use the horse-mounted crew. They could travel fast, cover a lot o fire line hot spots, and camp on water and still reach the fire by daybreak they were economical and easy to outfit; and they were immediatel available. A new base camp was established at Jack's Springs, the closes water supply, 5 miles from the fire.

The first attack ground crews were released the evening of the secon day. A well-organized crew of four working overhead and six fire fighters each mounted on a horse, and each self-sufficient, hit the fire at day light on the third day and had covered the entire fire line by 11 a. m

[H]ot spots that flared up, as far as a quarter of a mile away, were reached [i]n fast time and since the men were not exhausted from walking in the [l]oose sand their work was considerably more effective. The fire was held [o]n the third day except for one small slop-over of 5 acres. Again the next [d]ay, the mounted crew hit the fire at daylight and by midafternoon had [it] under control. The fire was then turned over to a five-man mounted [m]op-up crew.

Of course, all such fires cannot be suppressed by a small crew, yet this [e]xperience did point up a few things important to the control of fires in [in]accessible pinyon-juniper areas of low timber and watershed value. Some [of] these are:

1. Fatigue, merely from walking, is an important factor in control of [fi]res in hot, semiarid areas. In this case, the extreme fatigue from walking [to] the fire and around it resulted in several injury cases. We can assume [th]at the number of such injuries would have increased proportionately [ha]d larger numbers of men been used.

2. A well-organized horse-mounted crew could reach dangerous spots [an]ywhere on the line within a few minutes; the men were fresh and ready [fo]r a tough job. In this case, men worked in pairs under a boss who scouted [ou]t his sector and then used his crew most effectively. The fire boss rode [th]e entire fire line, catching dangerous hot spots as he went or directing [cr]ews to them. This small mounted crew replaced fifty to one hundred [co]nventional foot fire fighters.

3. There was a tremendous saving in costs as well as a big reduction [in] the job of transporting, feeding, and supplying crews. Foot crews [w]ould have cost from $3,000 to $6,000 for the 2-day job while the horse-[m]ounted crew actually cost about $500.

4. There was a considerable reduction in actual hours of fire fighting [ti]me. The horse-mounted men got their needed rest because they did not [ne]ed to walk half the night getting into positions on a fire line.

5. Each man was independently outfitted. They arrived on the job [fu]lly equipped with tools, hay and grain, and food enough for a week.

The suppression action taken in this type of semidesert country proved [to] be efficient and economical.

Television for Fire Control

"An uncommon and interesting use of television in fighting forest fires appears [to] have been applied for the first time in Bechuanaland [Union of South Africa]. [In] April 1949 two planes, one equipped with a television camera and the other [us]ed as a relay, were flown along the front of a vast forest fire stretching for about [..]) kilometers. The pictures broadcast gave the Forest Inspector in his office a [ge]neral view of the advance of the fire and of the various phases of the struggle [ag]ainst it conducted several kilometers away by the forest rangers, farmers and [fir]emen who had been called to the area; this 'first-hand information' allowed for [ef]fective command decisions in fighting the fire."—From UNASYLVA 4(3):142. [(A]n International Review of Forestry and Forest Products, published by Food and [A]griculture Organization of the United Nations.)

MICHIGAN TRACTOR-TANKER

GILBERT I. STEWART

Supervisor, Michigan Forest Fire Experiment Station

A tractor-tanker unit has been developed by the Michigan Departm of Conservation at the Forest Fire Experiment Station, Roscommon, Mi It is based on a wide gage crawler tractor, model AG-6. Mounted the front of the tractor is an industrial model pump employing rubb rotors. The pump is assembled into a compact gear housing that develo proper pump speeds, and is driven by a front power take-off. The trac driver can operate the pump at will by means of a selective clutch. proved type of bumper and guard, which has been standard with t Michigan Department of Conservation since 1935, is installed at the fro of the tractor. This has been improved and altered to provide the prop mounting for the pump.

Michigan tractor-tanker.

Two 135-gallon tanks are mounted, one above each track frame. The ·ntire tank assemblies are borne by the track frames, and no weight of vater or tank apparatus is attached to the tractor frame itself. The headights are recessed into the bodies of the tanks, thus giving a cleaner silıouette to the machine. Tanks are designed especially for this job and nay be secured commercially. Features of the tanks include bolt-down ops permitting easy cleaning and interior maintenance; perforated pipes ›pen at both ends of the tanks and run the full length to permit complete lushing of the tank interiors without the tops being removed.

The left tank includes a live reel with a hose capacity of 100 feet; the ear of the right tank accommodates the battery. Valves permit water to ›e circulated free of pressure within the tank systems, or to be passed ınder pressure into the live reel at will; the pump is thus primed at all imes and ready for immediate use, Shut-off nozzle guns are used with his machine. The pump installation has been designed to permit pumping rom the mounted tanks or from a tanker trailer towed behind the machine, ›r it may be employed for conventional line pumping. Pressures range up o 200 pounds and capacities up to 40 gallons per minute.

Full tool equipment is contained in a sturdy tool box mounted on one ank; a tray on the right tank allows convenient access to shovel, ax, hain, or other accessories issued and used with crawler tractors.

The unit shown is the pilot model completed in May 1950 after almost 2 years of experimental development at the Forest Fire Experiment Station. Total cost is not yet known for volume production but may be stimated at about $600, excluding tractor. During development all ıecessary tooling, such as patterns for castings, templates, jigs, fixtures ınd similar accessories for production, was completed. The entire outfit an be manufactured in kit form ready for installation onto any AG-6 ractor. The same type of assembly will be worked out for D2 and D4 ractors.

(Continued from Page 9.)

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MAINE'S NEW FOREST FIRE PROTECTION PROGRAM

A. D. Nutting, *Forest Commissioner,* and Austin H. Wilkins, *Deput*
Forest Commissioner, Maine Forest Service

The Maine Forest Service has recently completed the first year of a new forest fire protection program. It is the outgrowth of object lesson learned from the Maine 1947 forest fire disaster and followed by th enactment of certain forest fire laws in 1949 by the Maine Legislature The major law provides, for the first time in the history of the Forestr Department, full responsibility for forest fire control over the entire State This is the foundation upon which the new set-up is being administered

Some background information is needed if one is to fully understan the reason for the changes. In Maine there are 16,692,000 acres of foreste area to be protected against fire. This represents 84 percent of the tota land area of the State. It should also be pointed out that 97 percent o the forest area is in private ownership.

The Maine fire of 1947 destroyed 102 houses in this town. Such devastation as thi resulted in the new forest fire protection program.

In the economic development of the State, the forested areas fall into vo distinct geographical divisions. The northern part of the State is ade up of a vast unbroken area of wildland townships except for a potato-owing farming section on the eastern border. It is an area with few ads, almost no permanent population, and rather rugged terrain. Here e problems of forest fire control are different from those anywhere else Maine. In the early 1900's, there was no State control organization and rious forest fires occurred. Landowners became concerned over their nual fire losses. As a result of their efforts the Maine Legislature in 09 passed a law creating the Maine Forestry District. It placed forest e control for this vast northern Maine wilderness area under the State orestry Department. The forest commissioner was charged with the evention, control, and extinguishment of all forest fires within the istrict.

A unique feature of the act is the special levied mill tax which provides nds to administer the forest fire control program for that area. The x has varied over the years and is at present 5 mills on every dollar luation in the District. Annual income is $300,000. This money can ly be used for forest fire protection purposes. It is believed that there no other State with a similar law providing for a special forest fire tax all privately owned land in unorganized towns. The fire record can considered good since 1909. This is probably due to State centralized ntrol and authority.

The Maine Forestry District for administrative purposes has four visions, each under a supervisor. The four divisions are subdivided into warden districts, the size and bounds determined largely by watersheds, cessibility, etc. Each district is under the direction of a chief warden. ne Forestry District has constructed and maintains 77 lookout towers, 500 miles of woods telephone lines, and many camps and storehouses. ne District has 2 airplanes and some radio installations. Wardens are ovided with ½-ton pickup trucks, patrol boats and canoes, portable wer pumps, hose, back-pack pumps, and hand tools. All personnel except pervisors and one pilot are seasonally employed (April to November).

In direct contrast to the District set-up are the organized towns of e State. The term "towns" refers to the 450 organized municipalities, ministered by boards of selectment and assessors, the New England town rm of government. These towns are in the southern half of the State r the most part. The forest area is 6,430,000 acres. Here the forests are all, broken-up tracts with thousands of ownerships. In general it is an ea with many roads, densely populated sections, and high fire occurrence t with some towns of small population closely resembling the Forest strict.

From 1891 to 1949 the individual towns have been responsible for their n forest fire control. The State never had jurisdiction and served only a cooperator. Over the years the State has gradually increased its sistance to the towns because many of the problems could best be met the State level. This assistance consisted of the construction and main-nance of 20 lookout towers, a number of camps, and storehouses, and nployment of 13 state wardens as cooperators in forest fire fighting and r training with trucks and equipment. Since 1945 the State has reim-rsed towns one-half of suppression costs up to 1 percent of the town's luation.

Under this old system, the towns were confronted with problems whi they could not handle. This was especially true when forest fires cross town lines or became very large and expensive. The forest fire disast of 1947 brought many of these problems out in the open and arous public opinion to the point that the situation had to be corrected.

To meet the public demand for corrective measures the State Forest Department conducted an intensive survey. During 1948 the departme held 300 public meetings to determine what the people wanted for program. From the many ideas and suggestions obtained an outline pl began to jell. After further study and contacts with selectmen, fire chie wardens, landowners, and others, five major forest fire bills were draft for legislative consideration. Resulting laws were finally enacted by t 1949 Maine Legislature and became effective August 6 of that year.

In brief these forest fire protection measures are as follows:

State forest fire prevention and control in organized towns.—This la established a set-up plan from former State cooperation with towns State forest fire control in all organized towns, cities, and plantations. provides for an unbroken chain of command from town forest fire ward to commissioner. A maximum amount of responsibility and authority w remain with each local community, but State authority is provided whe ever the town system breaks down.

To administer this program, the forest commissioner shall divide t organized towns into major forest fire control districts. These shall subdivided into as many smaller units as deemed necessary for effecti protection against loss or damage by forest fires. The forest commission may also establish lookout towers connected by telephone or radio; co struct, equip, and maintain office-storehouse headquarters for necessa supplies, tools, and equipment; and provide for any other constructi essential for forest fire prevention and control work.

The law further provides for the appointment of full time State for fire wardens. Their duties shall consist of supervision of State personn and equipment in their respective districts for the prevention, control, a extinguishment of forest fires. They also shall enforce all laws relati to forests and forest preservation and shall have the same power of arr to serve criminal processes against offenders as a sheriff or his deputy. addition these wardens shall be responsible for carrying out a program forest fire prevention education, prepare and revise annually a forest fi plan for their districts.

State seasonal forest fire wardens shall be responsible to their distri warden.

It is important to note here that management of town forest fires sh be the responsibility of the town forest fire warden until, in the judgment a State forest fire warden, the situation makes it advisable for him to ta over. Final authority and responsibility on forest fires shall be that of t State forest fire warden. Town fire department personnel and equipme shall not be moved within or outside the town limits except with the a proval of the fire chief or proper town official. Such officials shall ha the authority to determine whether town fire department personnel equipment is needed on a forest fire or to protect buildings.

Only State forest fire wardens shall have the authority to set backfir

Provisions are also made for the Forestry Department to formulate pla of action to establish manpower pools, equipment reserves, facilities f feeding fire fighters, transportation and communication on forest fires.

Appointment of municipal town forest fire wardens.—The forest commissioner shall appoint a forest fire warden for a 3-year term in each organized town, city, and plantation. Such appointments shall be made with the approval of the municipal officers and does not constitute State employment. A municipal officer, fire chief, fire ward, or any other citizen is eligible for appointment.

The State appointed town forest fire warden shall receive an annual fee of $50 from the State. Payment is contingent upon attendance at forest fire training schools and preparation of an annual forest fire plan for the town. This forms the nucleus for a well-trained force of 450 town forest fire wardens and 1,500 deputy town wardens.

Services by these wardens for work on actual forest fires shall be paid by the town and at a rate determined by the town.

Forest fire fighter pay and aid to towns in controlling forest fires.—In the past many towns of small population have been hit hard by heavy forest fire suppression costs. Many bills went unpaid. Some towns sought reimbursement through the legislature while others borrowed money from banks and made payments prorated over a period of years.

Under this bill the suppression cost burden is eased by the State paying one-half of the suppression costs up to 2 percent of the town's valuation. All suppression costs in an amount greater than 2 percent of the town's tax valuation shall be paid by the State.

No State reimbursement payments shall be made until the town first shows certified payment. All qualifying costs must be approved by the State forest fire warden in charge. Requests for reimbursements shall be presented within 60 days after total extinguishment or become void. Time extension may be granted after major forest fires.

Slash and brush disposal.—This law provides that all slash must be removed a distance of 50 feet from the nearer side of all publicly used roads and on request by adjacent owner 25 feet from property lines. This must be done within 30 days after cutting or 30 days of notification to remove by the forest commissioner or his representative.

This act further provides that no person shall kindle a fire to clear land or burn logs, stumps, roots, brush, slash, fields of dry grass, pastures and blueberry lands, except when the ground is covered with snow, without first obtaining a burning permit. These are issued by State wardens in the Maine Forestry District and town forest fire wardens in the organized towns. Penalties are imposed for violations of this and the slash removal requirement.

A new prevention measure under this act is the hazard clearance around town and private dumps. A cleared strip 10 feet wide to mineral soil must be constructed on all sides of the dump, except when bordering on or near a large constant supply of water sufficient for protection. In addition all grass, weeds, slash, brush and debris, and other flammable material shall be removed for a distance of 100 feet in all directions from the cleared mineral soil strip. Live trees need not be removed except that dead and green branches of conifers or evergreens shall be pruned to a height of 10 feet above the ground.

Town and private dumps may be closed by the State or town forest fire warden if the provisions of this section are not carried out. Many towns have dumps which are near woods and constitute a forest fire menace. To meet this problem towns are being encouraged to relocate to a safer place

or construct a suitable public incinerator. In some instances towns a using trenches and covering the debris with bulldozers.

Primary wood-using portable sawmills, spark arrestors, and timber r ports.—All primary wood-using portable sawmills must be licensed and r quire a fee of $25. Failure to secure a license is punishable by either fine or jail sentence or both. An added forest fire prevention measure ca for a hazard clearance of all slash for a distance of 50 feet in all directio from the mill, sawdust pile, and incinerator. Live trees need not be r moved but dead and green branches of conifers or evergreen trees sh be pruned to a height of 10 feet above the ground. The area for t sawdust pile shall be clear of all trees and located not less than 25 fe from an incinerator. The sawdust pile shall be reasonably free of slabs a edgings.

The act further provides that all primary wood-using portable sawmi shall be equipped with a forest fire tool cache not exceeding a cost of $ for each mill.

For many years the State has been without any accurate information the annual timber cut. Under this act all owners or operators of prima wood-using sawmills, stationary or portable, shall make an annual repo to the forest commissioner of the amount of softwoods and hardwoo sawed within the State.

Conclusion

During 1948 and the spring of 1949, the State Forestry Department ha the voluntary authority and expanded aid from State funds to hand forest fire control before the new forest fire laws became effective. Sin enactment of the 1949 laws there is reason to believe that the new progra has proved itself.

Morale is high among the State and town forest fire warden personn who are a part of an organization making every effort to establish bett fire protection in the State. This has been accomplished by a series intensive training schools. Emphasis has been placed upon preventio education work, case history studies of forest fires, demonstrations in ha dling crews and use of equipment, training of volunteer groups, and oth public relations work.

From 1947 on, Maine has experienced four consecutive years of droug with an increasing number of forest fires. Yet better forest fire control a authority have prevented any serious reverses.

The recent Greenfield-Townships 32, 33, and 39 forest fire of 7,300 acr was a good example of coordination and supervision under one authori Under the old system it would not have been possible to pay all the su pression costs on the Greenfield end of the fire. The new program provid full financial payment to all fire fighters and for use of equipment.

Sufficient funds were provided to increase the warden service, to co struct 7 lookout towers and 18 office-storehouse headquarters, and to pu chase 20 ½-ton pickup trucks, 25 portable power pumpers, large qua tities of hose, knapsack pumps, hand tools, and radio equipment.

Radio communication was undoubtedly one of the most progressive pr tection measures under the new program. The State Forestry Departme now has a State-wide network of 9 lookout tower radio stations. In t organized towns the entire State warden service will shortly be equipp

ith mobile sets installed in ½-ton pickup trucks. There are also a number ' handy-talkie sets. Similar mobile installation is planned for wardens in ıe Maine Forestry District.

Two other important measures which will strengthen the fire protec-ɔn program of the State are the preparation of a State forest fire plan ıd participation as a member of the ratified Northeastern Interstate Forest re Protection Compact.

Volunteer public cooperation to control forest fires usually develops only ter a disaster has taken place, and is too late to prevent hardship and ss. Such a situation must never be permitted to occur again. It is hoped at under a single authority this new program will provide the necessary rest fire protection in Maine.

Box and Crate Construction for Safety

Safety pamphlets, leaflets, and instructions continually stress the importance of ting with the legs instead of stooping over a heavy object and lifting with the ck muscles, a practice which causes sprained backs, injured vertebrae, ruptures, d other semipermanent and permanent injuries.

On all units I have visited, almost invariably boxes that house heavy objects, ., pumpers, grinders, stoves, and other equipment, have an ordinary rectangular x with a hinged lid on top. When one man is required to remove the object ɔm the box it is a physical impossibility for him to lift the object properly be-use the box is in the way. The effort in lifting is exaggerated simply because e man lifting must keep his knees straight, bend over off-balance and lift the ject straight up, throwing excessive strain on leg muscles, knee joints, back and oulder muscles.

Would it not be a good idea to move the hinged lid from the top of the box the bottom on the side or end so the object to be removed can be slid out of e box with much less physical effort and strain?

All boxes constructed at the Mendocino warehouse for housing heavy objects 50 pounds and over now have a cover hinged to the side so that no lifting is quired to remove the object from the box.—AL EDWARDS, *Warehouseman, Mendo-ıo National Forest.*

[In other regions a special box has been used for heavy equipment, such as pumpers. ıe pumper is secured to the bottom of the box. The rest of the box serves as the . It is fastened to the bottom with four hasps and is removed in one piece. De-ces such as this author presents will undoubtedly pay dividends, in fewer injuries, ıere heavy equipment is involved.—Ed.]

SALMON HOSE ROLLER

R. Boyd Leonard

Fire Control Officer, Salmon National Forest

The cleaning and rolling of hose after it has been used is normally tedious job. It is not only time-consuming, but the roll is often untidy ar loose. We then experience difficulty in handling and storing, and fr quently the rolls come undone when we pick them up hurriedly to ser to another fire. The most common method of rolling hose is by hand. T do an effective job by this method takes two men and an estimated minutes per roll of hose.

In order to overcome the difficulties experienced in properly rolling ho by hand, an effective and durable hose roller was designed by Kennet Call, fire dispatcher, Salmon National Forest (fig. 1). Advantages of suc a roller were immediately apparent. It cut down the time required to ro hose and eliminated one man from the operation; neat compact rolls we secured (fig. 2). The roller is simple, inexpensive, and designed to make easier and faster for one man to roll fire hose. It is constructed of:

4 pieces of 2x4, 2 feet long
2 pieces of 2x4, 2 inches long
1 2x6, 2 feet long
1 ½-inch rod, 24 inches long
1 screen door spring hinge
1 nut and washer
a few nails.

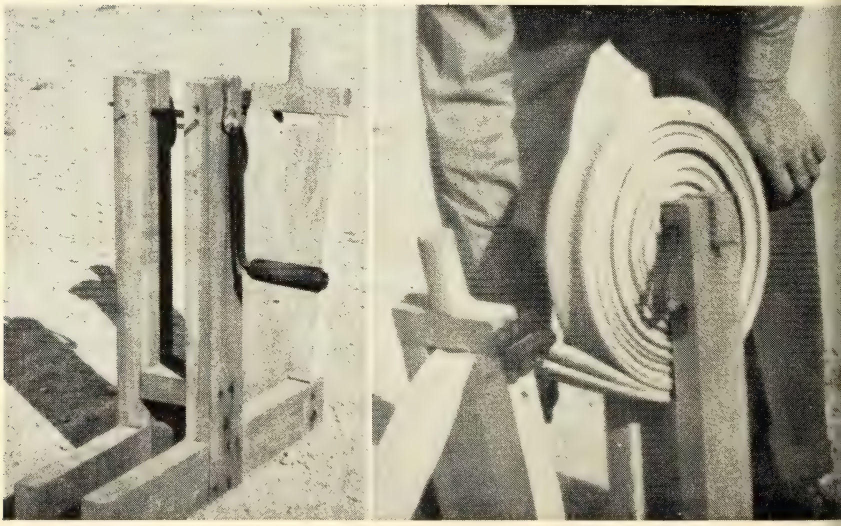


Figure 1.—Salmon hose roller: *Left,* Parts in place; *right,* roll being made.

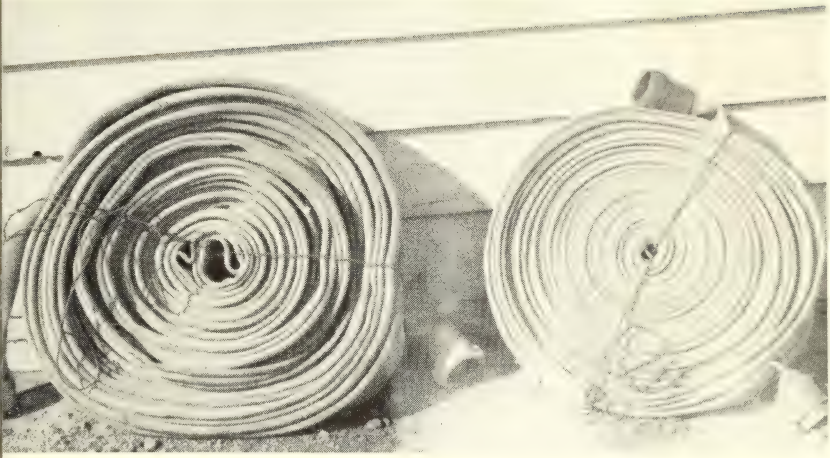


FIGURE 2.—Comparison of hand roll and machine roll.

The hose is doubled before rolling and is held by a hooked finger which welded near the center of the rod. The clamp opens to allow insertion of ie hose in the slot, and two nails slip into the holes across the crank slots hold the crank down when starting the roll. Before the roll is removed ie tying string is doubled and threaded through an eye in the end of the od. The crank pulls the string through the hose to simplify tying. Once ie operation of rolling the hose is started, it is only a matter of turning ie handle and holding down the roller with the left foot, unless it is amped to the floor. In our operations, we desire the mobile characteric so it can be put away conveniently when not in use.

Case for Crosscut Saws

A safe, convenient, and inexpensive case for crosscut saws can be constructed om a little lumber, a few screws, a piece of scrap metal and a bolt. The Prescott orest used 1-inch lumber, but 3/8-inch, 1/2-inch or even 1/4-inch plywood would rve as well.

The following was constructed for a 6-foot saw but dimensions can be increased decreased to fit any size saw.

Cut two boards 7 1/4 inches by 6 feet 2 inches. Cut two pieces of 1/4-inch plyood 1 by 7 1/4 inches to be placed between the ends of the two boards. Next, lay ie saw on one of the boards and cut two additional pieces of 1/4-inch plywood to tend along the side of the board next to the saw teeth, from the ends to the point here they touch the teeth. Now, place the two boards together, separated by the o plywood pieces at the ends and the other two pieces along one side. Fasten gether with screws.

Drill a hole near the side which is opposite the saw teeth, so it will clear the ick side of the saw when encased. Place two 1-inch cleats approximately 1-1/2 feet art, at equal distances from the drilled hole. This distance can be varied to acmmodate the handles which are placed between the cleats.

Next, a piece of metal, approximately 1 inch wide and long enough to cover the o handles, is shaped to hook over the outer handle and a bolt welded on to ie other end. The bolt is then run through the hole, with the piece of metal over ie handles, and fastened with a wing nut. This holds the saw in place as well as ie handles and makes for convenient and safe carrying or storage. The case can painted and the name of the forest stenciled on.—DOOLEY B. JONES, *Fire Conol Aid, Prescott National Forest.*

A NEW BELT-TYPE, FIRST-AID KIT

Horace E. Hedges

Regional Safety and Training Officer, Region 4, U. S. Forest Service

Early in 1949 the personnel of the Teton National Forest in Wyomin suggested that a larger and more complete first-aid kit be develope for fire line use since the present one-man kit was inadequate excep for treating superficial injuries. The standard larger kit is cumbersom relatively heavy and awkward to carry, and because of these disadvantage often is left at headquarters or main camps. Our experience with man injuries on the 1949 large, hazardous Payette fires further emphasize the need for a better field first-aid kit. Here again the conventional sma pocket kit was useful only for treating small cuts or minor injuries. I more serious injury cases, such measures as airplane dropping or long time-consuming hikes were required to bring in additional first-ai supplies.

This need for a better field kit was presented to the Fire Control Equip ment Development Committee, and Region 4 was assigned the job designing, developing, and assembling a kit for on-the-job crew us Fire control personnel and the regional safety officer, working togethe drew up plans for a belt-type kit which would contain adequate first-ai supplies for four to ten men and which could be easily carried. Fro these plans, canvas carrying cases were constructed at the regional smoke jumper loft. They are designed to be carried around the waist, with ey lets for holding an Army-type quart canteen on one side and lunch ba on the other side.

Heavy canvas is used for the outer covering and an oil silk liner pro tects the contents from body perspiration seeping through the canva

Figure 1.—Kit fits comfortably; belt has special eyelets for fastening canteens lunch.

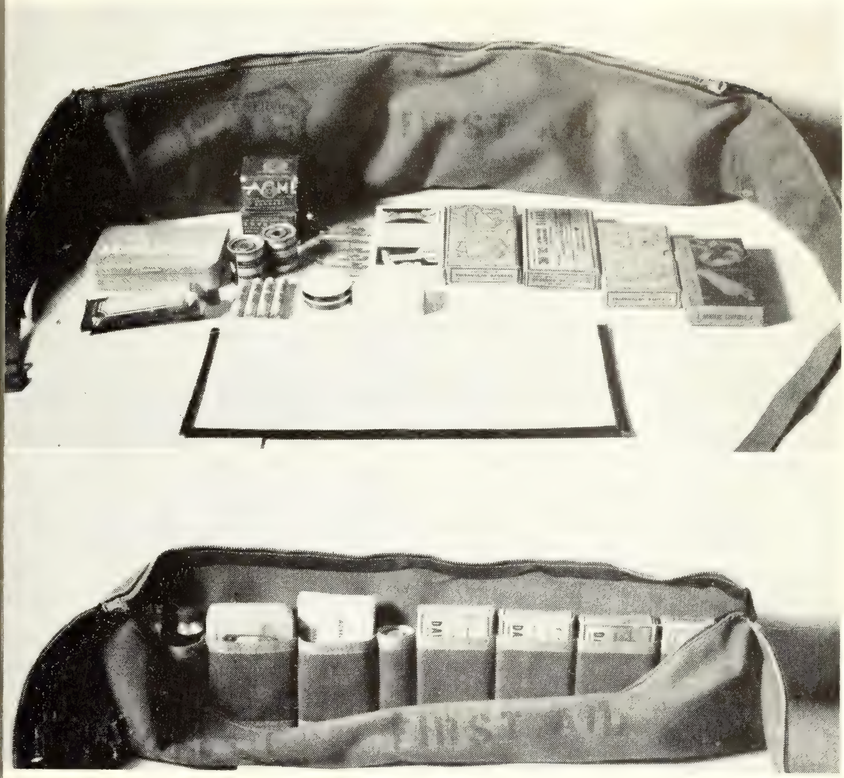


FIGURE 2.—Belt-type, first-aid kit: *Top,* contents laid out and zipper closed; *bottom,* contents in specially prepared pockets are held firmly in place.

A 22-inch zipper extends the length of the pocket section of the belt. The total weight of the completely filled kit is 1 pound 11 ounces. It is light enough to be carried without any appreciable inconvenience, and the wearer has both hands free (fig. 1).

The kit contains the following materials: Tube of white petroleum jelly; 2 sterilized gauze bandages; snake bite kit; 3 triangular bandages (not sterile); 2 rolls of adhesive tape; 4-inch bandage compress (sterile); 1 package each of methiolate (breakable pearls), 5-grain aspirin tablets, aromatic ammonia pearls, and safety pins; and a plastic-covered card listing contents and brief first-aid instructions (fig. 2). First-aid supplies are adequate to treat most serious injuries that result from fire or other forest work. A 25-man headquarters kit carries all replacement items of correct sizes for the crew kit.

A number of the belt kits have been constructed and will be given field trials. Following the trial period recommendations from field men will be consolidated and changes made toward further improvements. It is planned to equip fire, road, timber, and other field crews with the belt kits by the 1951 field season. As long as the kit is in an experimental stage all construction and assembling will be done as a winter project at the Region 4 smoke-jumper loft.

THE MINNESOTA FIRE FINDER

Roger Williams

Cartographer, Division of Forestry, Minnesota Department of Conservation

The device described here was developed in 1949 for the Minnesota Forest Service in answer to the need for a fire finder more accurate and dependable than those we had been using, and more economical than some of the commercial instruments in general use. In designing it, our objective has been to produce an instrument simple in operation, durable, low in cost, and small in over-all dimensions for convenience when used in our smaller tower cabins. Distinctive features of the device are the novel system of linkage that permits parallel movement of the graduated circle and the use of materials, unusual for this purpose but especially suitable.

Briefly, the fire finder consists of a triangular base and a triangular platform and movable circular disk, which are mounted on the base, all made of ⅝-inch Masonite die stock. This is a dense, rigid material made from wood fibers, light in weight and easily worked in comparison to metals, and with unusually high dimensional stability when subjected to extreme changes in temperature and humidity.

The triangular base is fastened to the supporting stand by wood screws. Set in its upper face are three stud bolts which extend upward through slotted openings in the triangular platform; this platform may be clamped firmly to the base by tightening the nuts on the stud bolts. Loosening the nuts permits the entire assembly to be rotated about 18 degrees in order to orient it properly.

Set in the upper face of the platform are three ⅜-inch steel pins, and the under side of the circular map board carries a similar set of pins. When assembled, the two sets of pins are connected by three links made of die stock, each link having two holes spaced 2½ inches apart, to receive the pins. The map board may thus be moved in a circle 5 inches in diameter, as it glides on the polished ends of the upper set of pins, which bear on the triangular platform. This permits a total shift of 5 inches for dodging obstructions in the tower cabin. The original orientation of the graduated circle is rigidly maintained in all positions.

The alidade is made of ¼-inch die stock, and turns on a bronze pivot working in a bronze bushing fitted in the center of the map board. Its two hinged brass sights may be folded down when not in use. The front sight carries a vertical sighting wire made of a single nylon filament, such as is used for fishing leaders. The rear sight has a vertical slot 3/32 inch wide. Slots of various widths were experimented with. It was found that with slots much narrower than this, not enough light entered the pupil of the eye, so that some difficulty was had in detecting distant smokes under conditions of poor visibility. Wider slots, on the other hand, per-

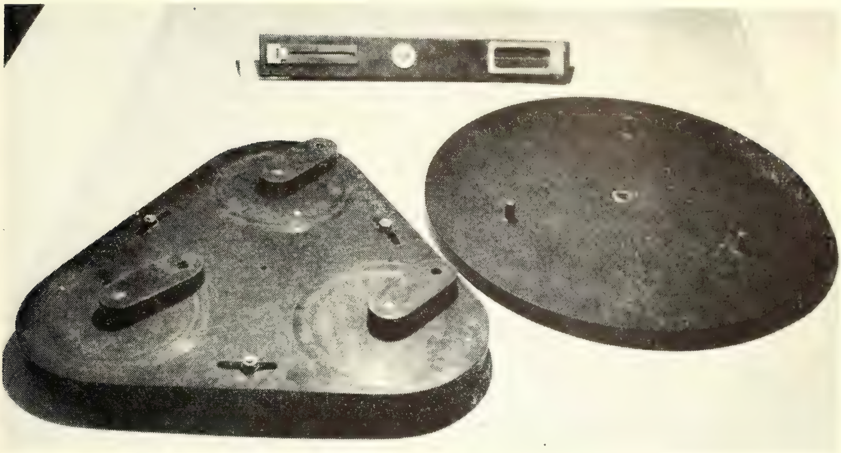


FIGURE 1.—Fire finder before assembling, showing platform with parallel linkage and under side of map board.

mitted some error due to imperfect centering of the eye on the slot. The 3/32 inch width was selected as the best under most conditions.

At the rear sight end of the alidade is fastened an index plate of ¼ inch clear Plexiglas, with a red index line engraved on its under side for reading the graduated circle. The alidade is set so that the index plate rides about 1/16 inch above the circle, and may be pressed down against the circle when reading a direction. The index mark then being in contact with the graduations, all chance of error due to parallax is eliminated.

The azimuth circle is printed on a sheet of Ozaplastic 15 inches in diameter. This is a paper coated on both sides with a plastic material, and sensitized with an Ozalid solution for contact printing. The original was drawn on acetate sheeting, and prints were made in a vacuum frame to eliminate any possible distortion of the image which might be caused by slippage or crawling in the usual rotary printers. This sheet is carefully centered on the axis of rotation of the alidade, and cemented to the board with a resorcinol resin glue. The circle is graduated to single degrees. Since on this large circle azimuths may be estimated to one-half or one-quarter degree, and since no smaller interval than this can be platted on the dispatcher's maps now in use, no further subdivision of the full degrees was considered necessary. If readings to a smaller interval are desired, it is a simple matter to add a vernier scale on the under side of the index plate, reading to 15, 10, or 5 minutes of angle.

Before placing the fire finder in the tower, azimuths to several check points visible from the tower are marked in ink on the graduated circle. True azimuths to these points are being determined by triangulation survey covering all our towers, which is now in progress.

The original model of this fire finder included a map which was cemented face up to the under side of a circular disk of Plexiglas ⅛ inch thick. On the upper side of the Plexiglas was engraved the graduated circle, the incised lines being filled with red ink. The disk and map were then cemented to the map board. The alidade carrying the sights was made of clear Plexiglas so that the map could be read through the

forward end of the alidade. However, serious difficulties, and some additional expense, were encountered in assembling the map and disk. Since our towers have for several years been provided with a small crossing map similar to the dispatcher's map, it was decided to eliminate the map from the fire finder, and the present simpler arrangement was adopted.

The instruments are being manufactured in our own machine shop, no special equipment being required other than the tools generally found in such shops. Total cost of materials is about 5 dollars. Plans or additional information may be obtained from Director, Division of Forestry, Department of Conservation, State Office Building, St. Paul 1, Minn.

FIGURE 2.—Fire finder assembled for use.

PORTABLE, COLLAPSIBLE FIRE CAMP TABLE

J. W. Mattsson

Forester, Division of Fire Control & Cooperative Forest Protection, Region 4, U. S. Forest Service

We have constructed a few collapsible fire camp tables, based on plans prepared by other regions plus a few alterations of our own. It was felt that such tables could be used to good advantage and save considerable time and effort. Very often rough tables have been constructed at fire

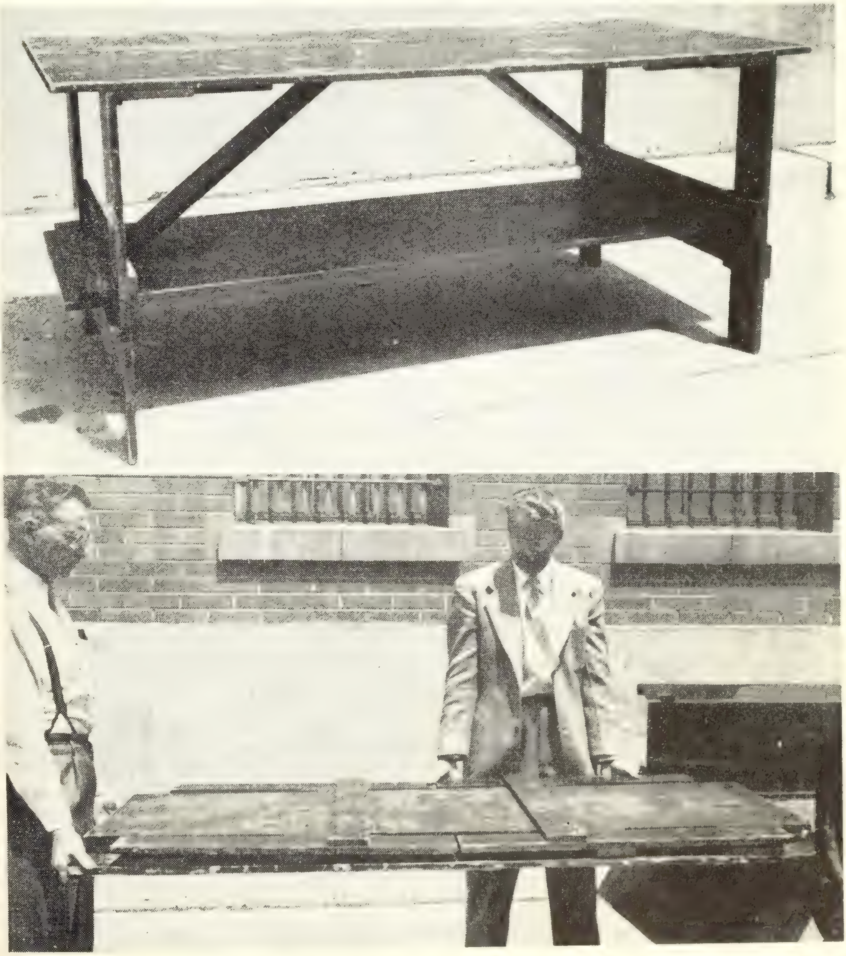


Figure 1.—*Top,* table in upright position. Note wide top and shelf below. The diagonal braces insure a rigid table. *Bottom,* fully collapsed table takes up little space in the bed of a pickup.

camps, even when such camps were accessible by truck, at the expens
of many man-hours that could have been spent more profitably on direc
suppression. These collapsible tables are practical, and are not too diffi
cult or expensive to construct. They have proved their worth for emergenc
fire use as well as at insect control and other field camps. On a fire thei
use is multiple; they serve such purposes as work tables for the kitchen
mess, fire boss, camp boss, and timekeeper.

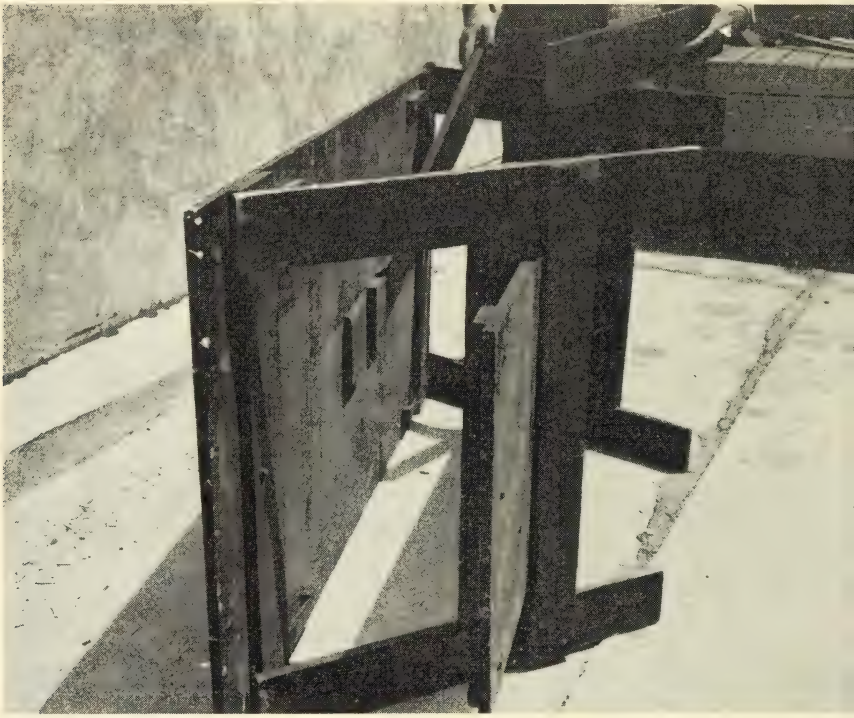


FIGURE 2.—Table partially collapsed showing how diagonal braces are set in. Thes braces are an important part of the table. They give it the necessary rigidity an solidness.

Construction is rugged enough to take a lot of abuse and the collapsibl feature makes it possible to drop the tables in the bed of a truck an load whatever is needed in the way of tools and supplies on top. The can be set up or taken down in a matter of seconds since there are n bolts or screws to remove or replace (figs. 1 and 2).

If such tables are to be used where a smooth surface is desired, it i recommended that 1/8 inch masonite top cover be placed on them. Thi would increase the life of the table top, provide a smoother writing sur face, and also facilitate cleaning.

Figure 3 illustrates the details of construction. Substitutions of materials of course, can be made if desired. Its construction does not require a expert carpenter. Considerable care, however, should be given to th construction and placement of the diagonal braces and brace blocks t insure a good tight fit.

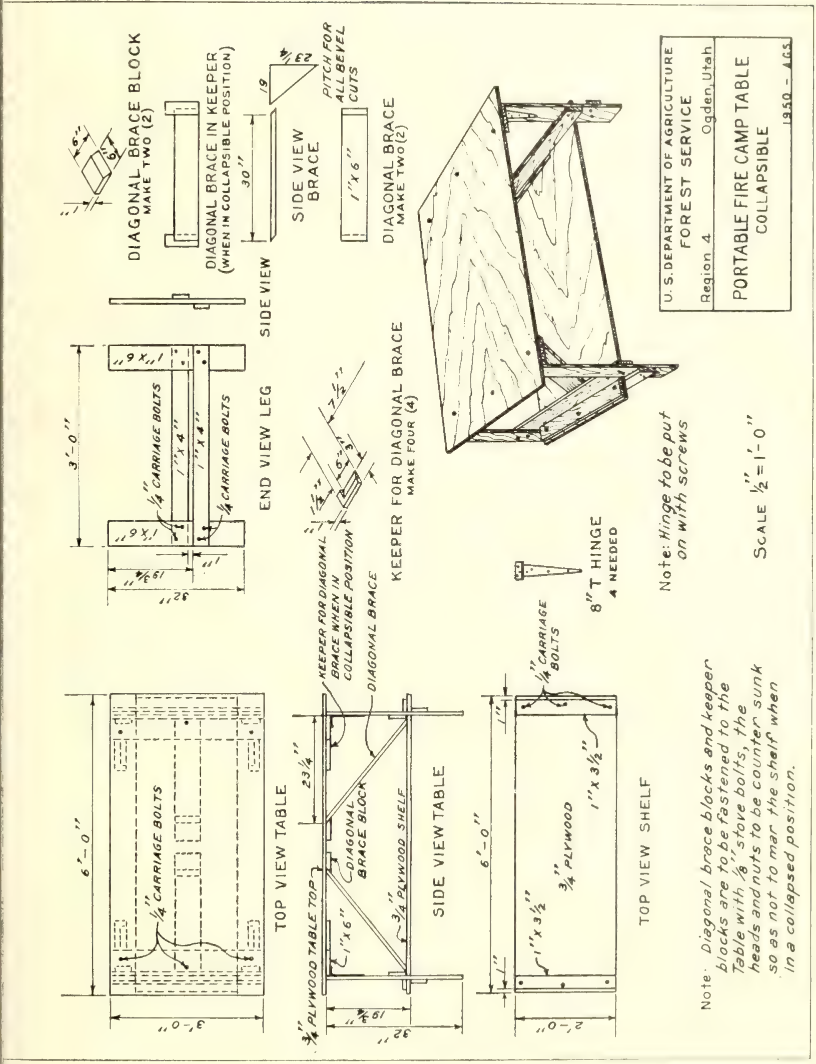


FIGURE 3.—Construction plans for collapsible fire camp table.

GETTING A NEW LOOK IN FIRE TRAINING

John E. Burt, Jr.

Deputy State Forester, Utah

How to combat 300 fires a year without funds to employ a full time fire organization has been the problem of both the Federal agencies and the State. Per diem fire fighters is our answer—cooperators from all walks of life, paid only when they fight fire. In order to make these cooperators effective fire fighters a great deal of effort has gone into fire training.

The fire control agencies in Utah have developed an interagency organization known as the Utah Cooperative Fire Fighters. This organization is headed by a coordinating committee, with a deputy coordinator from each agency, and the State forester as State coordinator. Each county in turn has a coordinator and assistants. Through this organization Federal, State, and county agencies can pool their efforts to train and tool fire fighters and coordinate their efforts in prevention and suppression work.

It has been the practice of the coordinating committee to meet early in the year to plan a spring training program to be taken to the field. When the group met in February this year we pointed out that our past training was lacking in certain fundamentals. Too many fires blow up because in our training we failed to put across the idea of proper mop-up. Another weakness was the proper handling of small crews in line construction. Better straw-boss training was needed.

This year the coordinating committee felt that a better job could be accomplished if members of the field organization participated. The State was divided roughly into four districts and three people from each district were invited to assist the coordinating committee in developing a program, including heavy emphasis on mop-up, organization and handling men in line construction, and safety.

The three people from each district, the coordinating committee, and Mr. Von Robertson from the State Education Department met in Salt Lake City on March 16th and 17th. The first day was an indoor session where everyone participated in planning a training outline. The second day was a field day in which we developed the training techniques to put over our training subjects. It was very difficult for most of us, as fire fighters, to think in terms of teaching and here Mr. Von Robertson came to our rescue. Too many times at fire schools we have gotten away from the job of teaching by putting out the fire.

We developed a rough outline of the various teaching steps as we demonstrated them in the field. This was later polished up, mimeographed, and sent to the field force. It consisted of three sections: Basic training fundamentals, planning the actual training program, and putting on the training program.

The three men from each district attending the planning session became a committee responsible for their own district fire school. Members of the coordinating committee participated in each of the four schools, acting as trainers and critics. County coordinators and assistants plus key people from all agencies were invited to attend the four district schools. Each school consisted of a six-hour program as follows:

1. Inside or outside orientation and outlining of program. Getting acquainted and letting the trainee know what he is expected to learn. 30 minutes
2. Field orientation and travel to practice site. Prepare trainee. 10 minutes
3. Assembly of men at practice site. This involves parking cars safely, unloading, and walking to selected area. 10 minutes
4. Training in progressive line construction. Telling, demonstrating, practice and critique. 1 hour
5. Presentation of mop-up. Explain reasons for good mop-up practice. Explain three phases of mop-up, primary, intermediate and final, and point out problems of each. 30 minutes
6. Demonstrate and practice on mop-up problems. Tell how, demonstrate, let trainees practice, put them on their own. 1½ hours
7. Review action taken on practice problems by all trainees. Final group critique. 1 hour

We have found that even with this limited subject matter our time was too short.

The new look came to our training by placing the trainee in the position that he was a teacher who in turn would have to teach someone else, and by following teaching fundamentals. This resulted in each man thoroughly learning the subject. Everyone was very attentive and participated with comments and questions. The summing-up period or critique was the clincher. We first let the trainee criticize the trainers and himself, then the critics made a summarization. From one of our meetings came the very applicable comment that we have had 10 to 25 years experience but we are still using only our first year's experience. This came from Richard Greenland, a district land manager, who feels that now with this training we are adding to that experience.

The four district meetings were very successful because they were planned and organized by the men who had helped develop the program. A great deal of time and effort was spent in this planning and preparation. These meetings were attended by a total of 210 people who represented Federal, State, and county agencies.

The trainees attending these district schools then carried out the same program in their local schools with a great deal of success. More than 500 fire fighters were trained at 20 local schools in May and June.

We hope to follow through on this program next year, choosing another phase or two of fire control and teaching it thoroughly.

Outlines have been furnished all regional foresters and State foresters. Some of the State foresters have been very complimentary in their comments. [The Utah State Board of Forestry and Fire Control, School of Forestry, Logan, Utah, has available a comprehensive mimeographed publication, Suggestions and Guide Points on Planning and Conducting a Cooperative Fire School.—Ed.]

A SIMPLE METHOD OF DESIGNATING MAP LOCATION

Robert F. Collins

Forester, Region 7, U. S. Forest Service

A problem confronting any forest fire control organization is that identifying a point on a map in a manner that will permit a person the receiving end of a telephone or radio transmission to locate quickly a accurately the same point on his map.

One solution is afforded by the "thrust-line" method. This method frequently used by the armed forces in situations where gridded maps a not available. In the most simple form it may be applied as follows:

1. Select two readily identified points on the map in the general area to worked and as far apart as is convenient.
2. Connect them by a straight line. This is the "thrust line."
3. Designate and label one of the points as the "initial point" (I.P.). measurements start at this point.
4. Any location on the map may now be designated by a symbol consisti of two parts: Distance along the thrust line from the I.P., either forward (or back (B); distance right (R) or left (L) from that point at right ang to the thrust line.

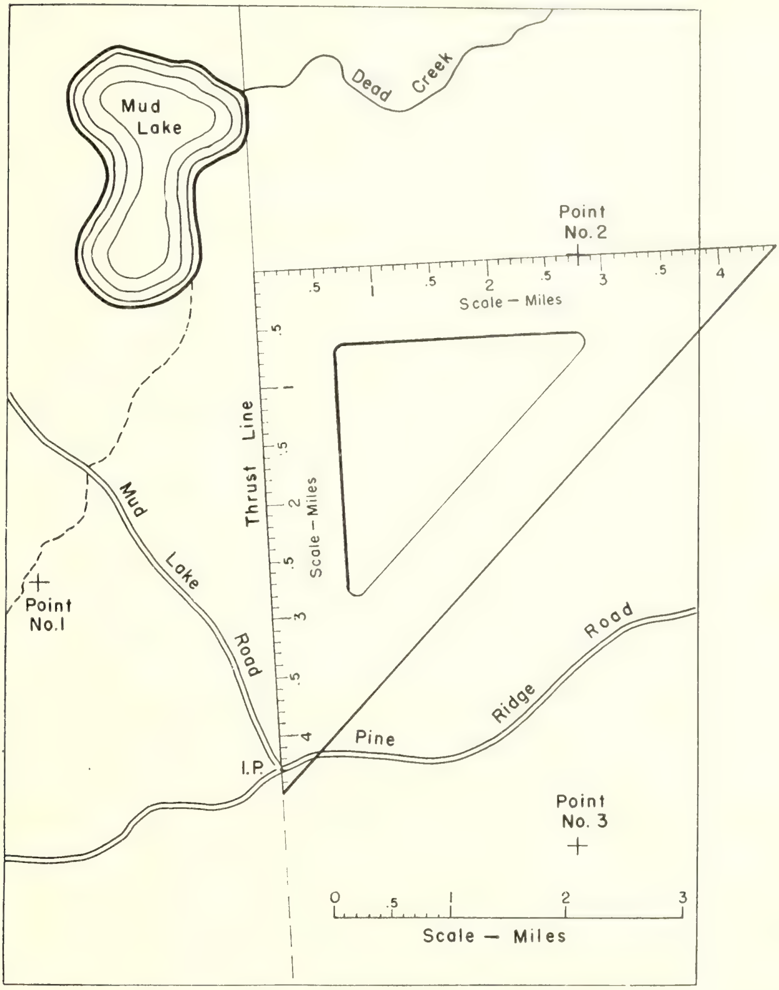
An aid in applying this method is a paper, cardboard, or plastic rig triangle having both of the sides graduated in the major map units a tenths of units, the zero of both scales being at the right angle of the t angle. By laying the triangle along the thrust line with the "zero" forwa and the required "F" distance at the I.P. the "R" or "L" distance may plotted directly.

An example of the use of the thrust-line method is shown by the sket map. Point no. 1 is designated as *F* 1.7 *L* 2.0. Point no. 2 is identified *F* 4.3 *R* 2.8.

Many variations of this method may be developed to meet the ne of special situations. Where a large area of map is to be covered it best to establish several thrust lines well distributed over the area to worked. In such cases it is necessary to identify each thrust line by letter or number and to preface each point description by the identifyi letter or number of the thrust line to which it pertains. For example, the thrust line shown on the sketch map is thrust line III then the iden fying symbol of point no. 2 would be *III F* 4.3 *R* 2.8.

In some cases it is necessary to place the I.P. well into the map becau there is no easily identified point near the edge. In such cases the thr line may be extended to the edge of the map and points on this extensi shown as back (B) measurements. For example point no. 3 on the sket map would be identified as *B* 0.8 *R* 2.5. In all cases right and left a determined on the assumption that the observer is facing forward fro the I.P.

The thrust-line method is most useful in cases where maps having gr lines or regular GLO subdivision land lines are not available. In emergency the ordinary service station road maps can be used in co bination with the thrust-line method to good advantage.



Sketch map with graduated triangle placed on thrust line to locate point no. 2, *F* 4.3 *R* 2.8.

When two observers are using maps of different scale the same thrust-line symbols apply to both. However each observer must plot locations according to his own map scale.

The principal advantages of the thrust-line method are: It is simple to teach and use. It may be applied to any map. A single identification symbol will apply to all maps of the same area, regardless of scale. It is accurate; chance of error is reduced to a minimum. It is brief; map point description by radio or telephone reduces transmission time to a minimum.

The major disadvantages of the method are: Each location must be plotted. The accuracy of location is dependent on accuracy of plotting.

This method is primarily valuable to fire control organizations as an emergency or stop-gap method pending the receipt of gridded or subdivided maps.

RAILROAD FIREFOG

A. B. EVERTS

Division of Fire Control, Region 6, U. S. Forest Service

The problem of keeping railroad beds clear of grass, weeds, ferns, and other flammable material is a vexing one. Not only does such vegetation constitute a fire hazard and hasten tie decay, but in some cases, especially when the railroad undergoes a period of nonuse, it may actually hinder operation by making traction difficult.

This was the situation in which the Puget Sound Pulp and Timber Company of Bellingham, Wash., found itself in the fall of 1949. The company had 35 miles of logging railroad which had not been in use for a year. They also had a bridge to replace. Vegetation across the rails made it difficult for the locomotive to haul material to the bridge site.

At prevailing wage rates, cutting the vegetation by hand would be a slow and costly procedure. Spraying was considered and rejected. How about burning? The problem was put up to Bill Catlow, the company forester. The "machine" that finally evolved was a combination of firefog and a propane-Diesel oil flame thrower, both of which have been previously reported in Fire Control Notes. Bill Cheney, of the W. C. Cheney Manufacturing Company of Seattle, a man with an inclination to try out new ideas, drew up a rough design and company management gave approval. The unit for this large-scale job is shown in figure 1.

Flame Thrower.—Eight 2-inch burners were suspended behind a railroad flatcar in such a manner that the flame from four of the burners was brought to bear between the rails. Two burners on each side pointed outside the rails. Since this was the first unit of its kind and considered to be experimental, provisions were made for adjusting the burners as to angle and for raising and lowering the entire assembly.

Four 125-gallon spherical liquid gas tanks of commercial design were mounted on the flatcar. Two of these contained propane and two Diesel oil. If freezing should occur because of the volume of gas being withdrawn, it is possible to shift from one propane tank to the other. By using this type of tank, it is also possible to take advantage of the price saving of bulk delivery of propane.

The four tanks were subjected to a 400-pound hydrostatic test, and the safety release valves were set at 180 pounds. As in the firefog unit and the flame thrower, the propane gas pressurizes the Diesel oil. Not only does this arrangement eliminate the need of a pump, but the propane gas bubbles in the Diesel oil make a hotter flame than Diesel oil alone.

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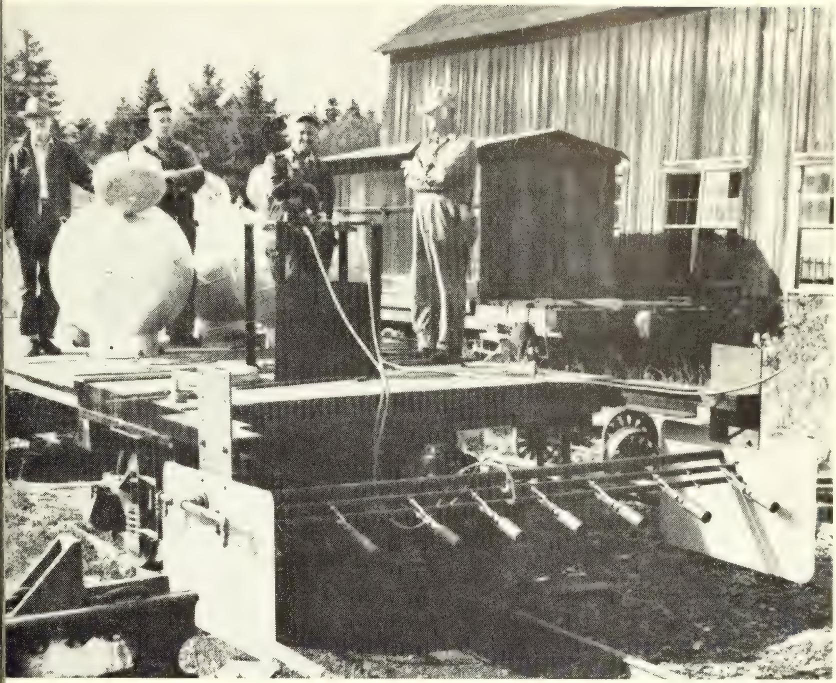
[1]EVERTS, A. B. FIREFOG UNIT. U. S. Forest Serv. Fire Control Notes 9 (2 and 3): 39-42, illus. 1948.

——— PROPANE-DIESEL OIL FLAME THROWER. U. S. Forest Serv. Fire Control Notes 10(1): 30-33, illus. 1949.



IGURE 1.—Railroad firefog showing fog plates and tips. The lower $1\frac{1}{2}$-inch pipe carries propane gas; the middle pipe, Diesel oil; and the upper 2-inch pipe, water for the fog tips. The hose connection between the control box and water pipe is not shown.

)nce the burners are in operation, except for pressurizing the oil tanks, ery little propane gas is used by itself.

Fog Control.—Originally it was planned that the vegetation would be urned while it was dry or curing. Thus, some means of confining the re to the burned strip were necessary. It was thought that this could est be done with water fog. With a 10,000-gallon railroad tank car behind e locomotive and in front of the burning car, conservation of water was ot a problem. Two steel fog plates were mounted as shown. On the utboard side of each of these plates two 15-gallon-per-minute fog tips ere provided. Thus, a total of 60 gallons of water per minute would e used in control, and the tank car would provide enough water for better an 2 hours and 45 minutes of operation. If less water was needed, one the fog tips on each side could be turned off, thus doubling the oper-ing time.

Low velocity, homogeneous-type fog tips were used. Normally, these ps produce a 10-foot circular ball fog pattern, but since they are mounted ose to the fog plate, the diameter of the fog pattern is cut in half. In her words, 15 gallons of fog per minute would wet down the vegetation r 5 feet on the outboard side of the plates while an additional 15 llons would strike against the plate and drip off in a heavy concentration.

At this stage, someone is sure to raise the question about the railroad es catching on fire. It was believed that, for the most part, the blast fect of the burners would so quickly consume the vegetation that tem-

peratures of sufficient intensity and duration to ignite the ties would be lacking. Nevertheless, it was planned to follow behind the burning car with a speeder to put out all fires that did linger in the ties. Because the burner performed beyond expectations, this problem, as will be explained later, did not materialize.

Controls.—A box with individual valves for the propane, Diesel oil and water control was provided for the operator at the burner end of the car. Propane and Diesel oil can be mixed so as to produce the type and intensity of heat that will best do the job.

Operation.—When the unit was assembled last October, it was found that the reflected heat was so great that protection was needed for the operator. Accordingly, corrugated sheeting was used to provide this protection (fig. 2).

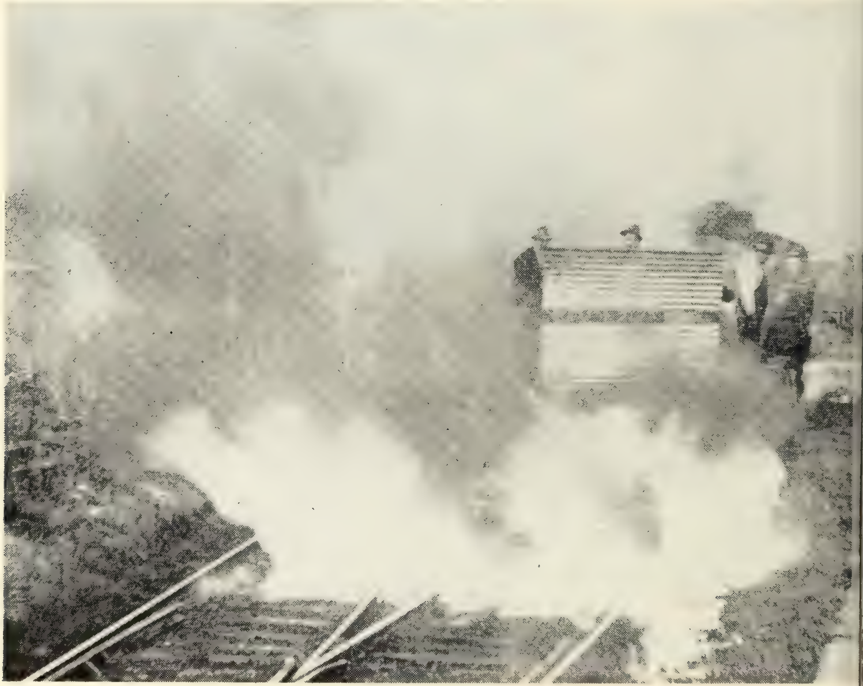


FIGURE 2.—Railroad burner in operation. Note protection provided for the operator.

It was raining when the unit was ready for test. Even though the vegetation was wet, it was found that the heat was so intense that burning could still be done. Therefore, it was decided that burning would always be done on wet days. Thus, the tie-burning problem was settled and with it the need for fog control, at least in this area of high rainfall. With the thought in mind, however, that other sections of the country might be interested in this railroad burner, the fog control has been included.

In the rain, an estimated speed of 3 miles an hour was obtained. A second pass over the roadbed was made at about 6 miles an hour. Last fall the roadbed was cleared to the site of the washed-out bridge (fig. 3).

'his spring, with the bridge repaired, the rest of the roadbed into the ogging-operating area was burned.

The fog plates have been removed and in their place $2\frac{1}{2}$-inch burners, ne on each side, have been added. These burners, set at 45°, point utward and thus further widen the burned strip. With the fog plates emoved, the burner assembly has been lowered much nearer the rails.

GURE 3.—The roadbed after the burner has passed over. All burning was done in the rain.

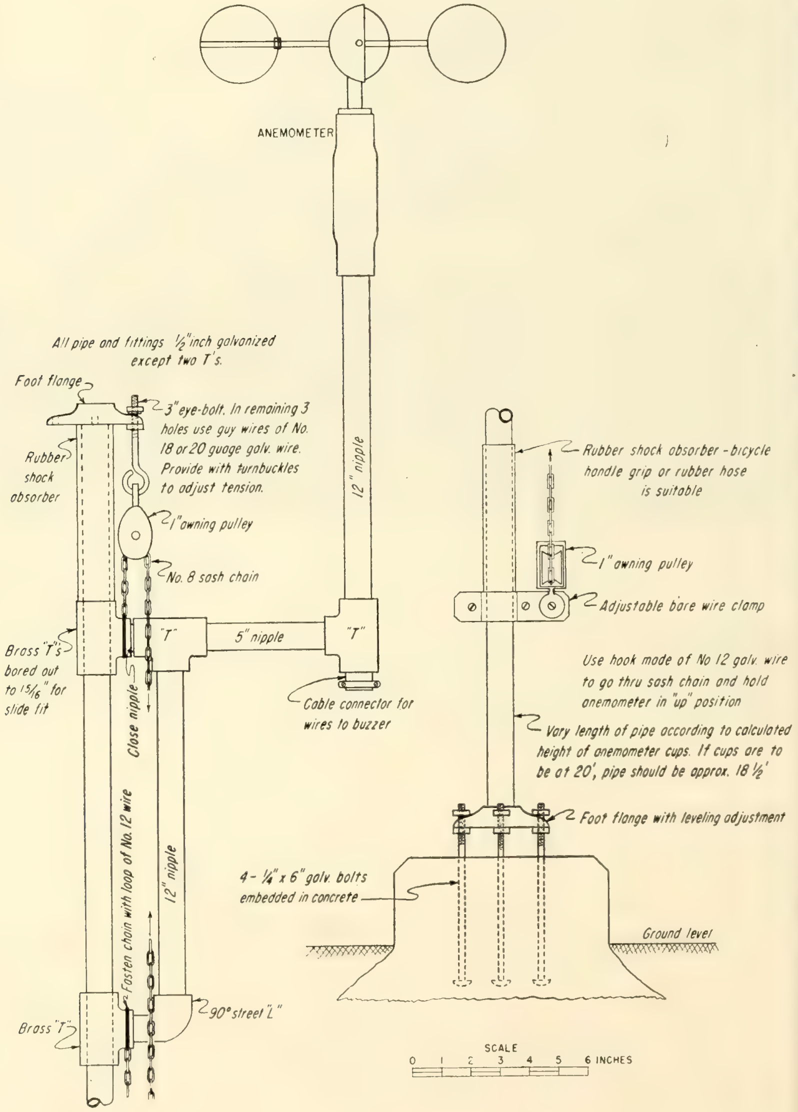
Latest reports indicate that two burnings will be made a year; one in e spring after the grass has had a good start, and again in the fall ter it has recovered from the first burning. It is believed these two urnings will keep the roadbed clear of vegetation.

[There is some danger in using propane for pressurizing a liquid fuel nk. Propane gas expelled when liquid fuel tank is refilled is a serious azard. One fire fighting organization discontinued such use because of e hazard and substituted air pressure.—Ed.]

HANDY ANEMOMETER MAST

A. W. LINDENMUTH, JR., *Forester, Fire Research, Southeastern Fores Experiment Station,* and J. J. KEETCH, *Danger Station Inspector, Region 7, U. S. Forest Service*

For mounting an anemometer approximately 20 to 30 feet above grounc level, this design for a mast provides economy, durability, and convenience One semiskilled worker can set it up using only a pipe wrench, screw



river, pliers, and standard hardware (except for the small concrete oundation and reamed brass T's). After it is in use, the serviceman will ive a lot of time while periodically caring for the instrument because ie anemometer can readily be lowered within reach and is easily pulled p to the standard operating height. Total cost for the mast: about $10 or materials plus 2 hours of semiskilled labor.

This equipment has been service-tested and found satisfactory. The gure gives all the necessary erection details, but these few supplemental iggestions are helpful: Use rustproof hardware. One-half-inch pipe is satfactory for masts up to 21 feet in height. Larger-sized pipe, also larger iding T's, are recommended for higher masts. A short stepladder is eeded when servicing the instrument if the mast is more than 25 feet high. Plumb the mast. The best way to do this is to screw a 2- or 3-foot piece pipe into the bottom foot flange: then align this short section with a irpenter's level. Use lightweight guy wires and take up only enough ack to hold the mast erect. If the mast is not plumb or if the guy ires are taut, the mast tends to bow.

Rest Camps for Large Fires of Long Duration

Due to someone's carelessness, a fire started on the Los Padres National Forest ily 5, 1950. The best suppression efforts of the Region were stopped or delayed by country so steep and rugged that it was impossible to use mechanical equipment to onstruct fire lines. The cover was tinder dry, with the constant threat of having a e crew trapped and burned to death. Helicopters were used to transport men and od to high, inaccessible places, while other crews fought their way on foot up the eep, rugged mountains to fight the spread. After a few days of such work, the e fighters would become exhausted and depressed.

Three weeks after the fire started a separate camp was established away from the rmoil of the main fire camp, where these exhausted men could rest, relax, and cuperate before again being sent back to the fire line. For this purpose, a Forest rvice public camp ground was taken over and closed to public use. The camp as on the banks of the Arroyo Seco and had plenty of fine shade, two swimming oles, bathhouse, latrines, and running water. The rest camp had its own kitchen, mmissary, and Red Cross set up. The camp ground tables were assembled near e kitchen, so that the men could sit down and enjoy a well-prepared meal. Three eals a day were served. Men coming off the line were checked in at the main e camp, and then sent to the rest camp, where they bathed, washed their clothes, ceived medical attention, and rested for 24 hours before being sent back to the e line. In many cases, it was hard to recognize the clean, fresh men who left e camp as the blackened, exhausted men who had entered 24 hours earlier.

The rest camp took a load off the main fire camp, and assisted in other ways the management of the fire. The maximum number of men in the camp at any e time was approximately 250. After the fire had been controlled, the camp was used segregate and assemble the various crews for dispatch to their home forests or ies.

The rest camp is an idea which should be considered for any fire of long duraon. All of the forest personnel in the main fire camp gave complete cooperation, d the fire fighters who spent time in the camp thought it a wonderful innovaon.—T. R. Littlefield, *Engineer, Division of Engineering, Region 5, U. S. Forest rvice.*

NEBRASKA FIREBREAKS

WILFRED S. DAVIS

Forester, Region 2, U. S. Forest Service

Firebreak building was a fairly popular work project in the days of th Civilian Conservation Corps. It enabled the employment of great number of men with hand tools and created swaths from which fire suppressio forces could make a stand. But lack of maintenance funds made it difficul to keep up these barriers when the CCC was disbanded, and most of th firebreak systems are today abandoned and overgrown.

The Nebraska National Forest, however, is keeping up a system c firebreaks that has been maintained since 1910. Without such a system it is doubtful if the forest could survive.

This national forest is located in the vast sea of grass-covered dune known as the Nebraska sand hills. Every tree on some 20,000 acres ha been planted. It is a successful attempt to show that a forest can b grown under the somewhat adverse conditions in the sand prairie, an represents one of the largest single afforestation projects in the worl (fig. 1).

FIGURE 1.—Successful ponderosa pine plantation growing in a flash fuel grass typ

Lightning and man for centuries have caused vast prairie fires to sweep across the sand hills. The chemicals in the ashes gravitated into the major depressions and created potash deposits, which were recovered during World War I and used in the manufacture of explosives. The repeated fires that caused this potash accumulation probably prevented the build-up of surface litter for more than a few years at a time.

When the plantation project was initiated, it was of course necessary to check periodic prairie fires in the afforested area. This soon caused an increase in the grass density between the trees and an accumulation of dry litter, which made it extremely difficult to check fires sweeping in from the outside (fig. 2). Consequently, a system of permanent firebreaks was devised.

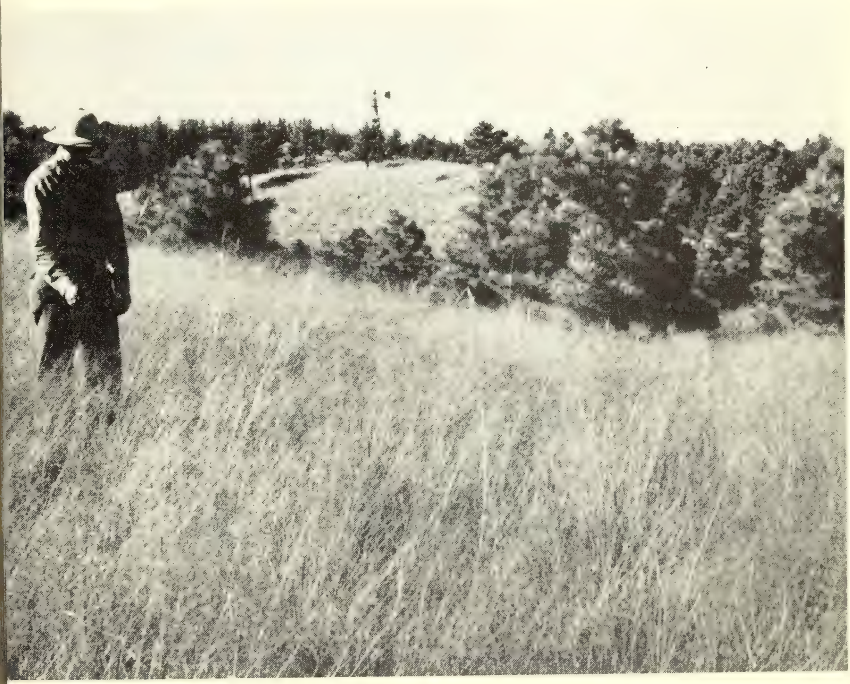


FIGURE 2.—Dense prairie grass on the edge of a plantation. There is enough litter on the ground to carry fire even when the grass is green. When the grass is cured, it will support fire of high intensity and rate of spread.

The basic concept of the firebreak system was (1) to provide protection against outside fires, and (2) to divide the planted areas into units of less than a square mile, so as to make interior fires easier to handle. Some of the first firebreaks were made relatively narrow; these proved ineffective in high winds, and wide standards were adopted.

The major exterior firebreaks consist of three plowed and disked 20-foot sand strips separated by strips of grass at least 150 feet wide. The sand strips are disked annually, to prevent vegetation from creeping in, and one of the grass strips is burned annually; two year's growth of grass is required for a clean burn.

The interior firebreaks are single lanes of grass edged by disked strips (fig. 3). The grass cover is burned off every other year.

The annual burning of firebreaks takes place in the fall, usually after the first frost has killed the annual growth of grass (fig. 4). A typical burning crew consists of 3 torch men, 2 guards, 1 tanker or tractor driver, and 2 mop-up men. The fire in grass goes out quickly, but mop-up

FIGURE 3.—Typical interior firebreak.

is required for smouldering cow chips and burning soapweed (yucca) plants. The crew soon becomes adept in the use of fire, and learns to employ terrain and wind to the best advantage. Three to five miles can be burned each day when the humidity is sufficiently low (less than 30 percent).

The maintenance of the Nebraska firebreak system is a considerable task, involving the disking of 594 miles and the burning of 61½ miles of grass lane annually.

Virtually all of the planted acreage of the Nebraska project was wiped out in the spring of 1910, when a disastrous prairie fire swept through the area. Since the establishment of the firebreak system in that year, however, plantation losses to fire have been small, despite the fact that there have been a number of large "outside" fires. These advance with considerable rapidity; in one instance, a frontal spread of 6 miles in 40 minutes was clocked. However, the planted areas have remained relatively free from fire invasion. Today, some of the older trees ar approaching

sawlog size, and natural reproduction is beginning to come in. Thanks to the protection system, of which the firebreak network is a vital part, an afforestation effort extending over nearly a half a century is beginning to bear fruit.

FIGURE 4.—Burning an exterior firebreak in the fall of the year.

Nonmilitary Aircraft

The following interesting information on all nonmilitary aircraft is a result of a Civil Aeronautics administrative study:

"More than half of the Nation's 92,442 registered civil aircraft are owned in 10 States. California continues to lead the list of States in aircraft ownership with 10,508 planes registered there—11.4 percent of the national total. The other nine leading States, in order, are Texas, Illinois, New York, Michigan, Ohio, Pennsylvania, Kansas, Indiana, and Florida.

"The study reveals that 62,496 of the registered aircraft are 'active,' that is, in general day-to-day use, with 29,946 classified as 'inactive,' although still registered. Of the total fleet, 86,533 are single-engine planes; 4,498 have two engines; 23 three engines; 575 four engines; and 1 eight engines. Of the inactive planes, 311 are classified as 'unspecified' because of the lack of data as to powerplant, model, or other characteristics. None of these has an air-worthiness certificate, and could not be granted one without the required data. In addition there are 469 gliders, 15 lighter-than-air craft, and 17 balloons.

"Ten 'Ford Trimotors,' forerunners of the modern multiengined air transport planes, are still registered as 'active.' They were built in 1928 and 1929."—From *CAA Journal, October* 15, 1950.

EMPTY CHAIRS IN FOREST SERVICE HOMES

Carl Burgtorf

District Ranger, Monongahela National Forest

What do we remember about forest fires? We remember the waste and our loss. We prevent fires in an effort to prevent this loss of human and natural resources. We know that not all fires can be prevented so we plan to meet that risk. Our safety plans are made to reduce or eliminate the loss of personnel in fire control. There are many grim reminders and sobering details of fatalities on the fire line, some of which are buried in the records, while others are burned into the hearts of those who will never forget.

How many empty chairs will fire fatalities leave in our homes in 1951? The year 1949 brought 18 deaths for the U. S. Forest Service directly attributable to fire fighting while 3 others died on fire duty as a result of heart condition. Judging from the 1949 fatality list the stage was set for death to strike 4 men: one, a T. S. I. crew member, was placed under a 140-foot snag which fell in the *unexpected* direction; the second was under a 65-foot snag, hollow and on fire, that also fell in the *unexpected* direction; the third was too close to a hollow snag, burning from top to bottom, that was caught in a gust of wind and fell *unexpectedly;* while the fourth was in a crew attempting to cut a 100-foot snag, which was on fire, with a power saw. 15 feet of the top broke off and fell on its victim.

After reading the reports of these four deaths a natural assumption is that snag felling is dangerous work. The next assumption might be that felling snags of uncertain soundness, hollow or otherwise difficult to handle, involves too much risk and should not be done by the usual felling crew operating at the base of the snag. Wouldn't that be a sound decision after four deaths by this cause in 1949?

How can dangerous snags be felled without cutting them off? Why not dynamite them from a safe distance? Experienced men blast miles of ditch line, etc., each year for the Soil Conservation Service without a fatality, so handling the explosives should be little more difficult than handling and hauling a power saw and gasoline. Certain dough type or packaged units of explosives used by military demolition squads might be far superior to regular dynamite.[1] At any rate the problem to eliminate is the need for men at the base of the snag, setting up vibrations with ax, saw, or other tool, trusting to luck for a safe escape. Why set a stage in which excessive risk is so evident?

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[1]Johnson, G. B. army explosives for hazard reduction. U. S. Forest Serv. Fire Control Notes 8(1): 42-44. 1947. This article describes tests of military explosive used for snag felling. The Northern Pacific Region of the Forest Service at Portland, Oreg., has published some mimeographed material on snag felling with explosives.

Fifteen Forest Servicemen died during 1949 from suffocation or burns. They were trapped by forest fires that changed directions *unexpectedly.* As each of these men was killed, or injured to die later, there were others nearby who made successful escapes. Who can say that fate played a hand in their escape. We can't count on fate to save our men so we must put our faith in a realistic training program.

The success of a safety program rests with the individual worker; accidents happen to individuals and in the final analysis, we might say, each worker rides in a driver's seat where he has the power to follow a clear trail or one beset with accidents. Some individuals are "accident prone." Why? Why does performance vary with different people? The answer is obvious; people are different.

When we consider the qualities which, outside of physical or mental capacities, have decided effect on a workman's performance, we find that as a person is confronted with a certain job, he will perform the work within a pattern. This pattern might easily identify each man's workmanship and is influenced by his inherent *skill,* past experience, and *training* and his *attitude* at the time. You have heard of good working habits, safe practices, safety consciousness, carelessness, thoughtlessness, and if you know your workman you may see these characteristics or notice their absence in his work pattern. How simple your safety job would be if you could hand each employee a "pattern package" containing skill, training and an excellent attitude.

The "pattern package" might seem to be as unrealistic as a flying saucer, and yet you have seen excellent supervisors or foremen develop skillful trained workmen with fine attitudes. Of course, these workers did not acquire their work pattern overnight. Trial and error, success and failure, practice with actual performance and thoughtful guidance each had its part in forming this pattern. The trained and skillful foreman in charge of the training program knew what he wanted his workmen to be like. He knew what pattern of performance he wanted from his outfit and he got that pattern by developing the skill, training, and attitudes of his men. The foreman had acquired a personal knowledge of what constitutes a pattern for workmen. Call it a standard of performance if you will, but each man's pattern must fit the standard in the final analysis. Each man must have skill, training, and a good attitude if he is to be consistent in quantity and quality of output.

What has all this to do with fire control? It reaches to the very grass roots of personnel management; it concerns the man driving the tractor, the man on the fire line, the straw boss, the foreman, in other words—the individual. It has usaully been some individual failure that put on the straw to break the camel's back. Seldom has equipment been directly responsible for accidents and in those rare cases it is usually found that some person through carelessness (attitude) permitted his equipment to become involved in situations which demanded results beyond the capacity to produce. "The brakes failed to hold," is frequently read in accident accounts. Most brakes fail to hold when the wheels are off the ground!

A recent Forest Service report indicated that the five chief causes of human failure in accident occurrence have been fatigue, haste, inadequate supervision, faulty instruction, and lack of attention or improper attitude. Fatigue, haste, and improper attitude are factors of direct individual behavior, but inadequate supervision and faulty instruction are the respon-

sibilities of leadership. These causes of human failure have resulted i: many deaths.

As supervisors of men we can attack weak points in our organizationa set-up. Most of us do. We think about the safety of our men frequentl and write reports and prepare records for distribution and filing. W have beautiful records—of accidents. Yet, how frequently do we fin ourselves attacking the symptoms instead of the disease. We think of fatigu and haste, two allies of the grim reaper, and we know that few men g to a forest fire who do not, at some time, get tired, or act in haste—it i that kind of a job. Fire fighters work hard and hurry. They must. Wil it do any good to tell them not to get tired or not to act in haste?

Let's refer to that "pattern package" mentioned before. Will we b attacking the disease instead of the symptoms if we give each man a goo dose of skill and training and check him for attitude?

Some of our leaders may have been taught to memorize such phrase as "be careful" or "don't do this or that." How much better we woul feel if we could step up to each leader, or foreman, and say, "Joe, yo have been given skill enough and training enough, and have prove yourself as a leader. You have been taught how to check each job an plan accomplishments in advance. When you 'feel' that too much ris is involved in a situation, after you have checked carefully, take heed— that will be your experience, your training, and your skill telling yo that an accident is just around the corner. That 'feel' or pattern of ex perienced reaction saved the lives of several men last year, Joe."

How many empty chairs in our homes this year will be due to th unexpected?

Volume 12 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

HELICOPTER USE FOR FIRE CONTROL ON THE WALLOWA FOREST

ERALD J. TUCKER, *District Ranger,* and JOHN B. SMITH, *Fire Control Staff Officer, Wallowa National Forest*

Helicopters were used at various times during the 1949 and 1950 fire ;asons for transporting men and equipment to forest fires on the Wallowa [ational Forest. Use of this type of aircraft to date has been confined to ie very rugged terrain of the Imnaha River canyon and in the spectacular [ells Canyon of the Snake River.

The Imnaha, a tributary of the Snake River, runs parallel to the Snake ɔr 50 miles at distances ranging from 6 to 18 miles. The country between ie two rivers is a land of rugged canyons, precipitous slopes, and great ms or bluffs. A road extends along the Imnaha River and connects with highway to the forest supervisor's headquarters at Enterprise, Oreg. A ne-way forest road extends for 24 miles from the Imnaha road to Hat oint lookout, which is located near the center of this area; there are no ther roads.

The Wallowa Forest has an airplane landing field located at Memaloose, ear the end of the Hat Point road (fig. 1). This landing strip is 60 miles om Enterprise and travel time required is about 3 hours by car, 4 hours y truck, or 20 minutes by airplane. The forest has another airplane land- ıg strip at Lord Flat, 20 miles north of Memaloose, which has no road onnections. There are few good trails, and travel by trail or cross country slow and sometimes dangerous or impossible. It is frequently necessary ɔ travel 5 to 10 miles to reach a point only a mile or two distant. The rea is covered with fuels that are generally flashy with high or extreme ate of spread.

Experience indicates that the helicopter is well adapted for use in this ɔadless area where elevations range from 1,200 to 7,000 feet. Although ɪost of the area has very steep slopes, there are numerous open ridge tops nd flat benches which make excellent landing spots for the helicopter.

Commercial helicopters from Yakima, Wash., were used in 1949 and rom Missoula, Mont., in 1950. All were two-place Bell machines and were sually able to carry a fireman pack or other equipment up to 50 pounds 1 weight in addition to the pilot and one passenger, the amount of freight epending upon the weight of the passenger. The machine from Missoula vas equipped with a wire basket cargo carrier mounted on the side, which ɪakes a convenient and practical means of hauling cargo and can be used ɔr transporting an injured person.

Base camps from which to operate the helicopters were established at ɔme point along the roads or at the Memaloose landing field, and ele- ations of these bases ranged from 3,000 feet at the Colvin Ranch to 6,700 eet at Memaloose.

Use of the machines is somewhat marginal at the higher elevations luring the middle of the day. However, they were used at all times needed

FIGURE 1.—Typical canyon country of the western Wallowas. Memaloose airstr
upper right; elevation, 6,700 feet.

except for a short time one afternoon during a period of considerable a
turbulence. During this afternoon, while the helicopter was grounded,
small fire started. Two firemen with horses were started over the 10
miles to the fire. Some 30 minutes later the helicopter pilot, after maki

trial flight, decided that it was safe to carry men, and in 42 minutes : had placed two firemen on a ridge top 300 yards from the fire. One reman had been taken from the base camp, and the second was picked ɔ at a lookout-fireman station some 10 miles from the base camp. The ɔrseback firemen arrived 3 hours later, after the fire was under control.

On August 3, 1950, Ranger Tucker and two firemen enroute to another e discovered the Black Butte fire in Hells Canyon. This fire was in a ind area not seen by lookouts, but since it was in flashy fuel and potentially

GURE 2.—Arrow indicates where helicopter landed fire fighters on the Black Butte fire. Smoke jumpers also landed on this ridge. Fire was still 1½ hours walking time from this point.

ost dangerous, they went at once to it. It was soon evident that more :lp would be needed, and a yellow streamer signal was placed for the ıtrol plane which had previously been requested to scout the area. A Iotorola handi-talkie was dropped to Tucker and he ordered men and ıuipment.

At 6:00 p.m. seven men left the road near the Memaloose airfield to alk to the fire, about 5 miles airline distance, but 7 miles by trail and 7 iles across country. They stopped enroute from 10:00 p.m. August 3 to :00 a.m. August 4 because night travelling was hazardous. They took the rong ridge in walking down to the fire from Black Butte and came out ı a ridge across a deep precipitous ravine from the fire. However, they ere within speaking distance, and, following shouted instructions from anger Tucker, they were able to make their way through the rims in ɔout an hour to the fire. They arrived tired out at 9:00 a.m. It took them hours walking time to get to the fire.

Fourteen smoke jumpers, six from Region 6 and eight from Region 4, ere used on this fire. They jumped near Black Butte on a timbered slope

and walked about 3 miles to the fire. Two arrived at the fire at 9:00 p.m. August 3, and the rest jumped early the next morning.

A helicopter from Missoula operating from Memaloose airfield ferried 14 local men to a flat ridge top near Black Butte, which was about 1½ hours walking time from the fire and near where the jumpers landed (fig. 2). Airline distance for the helicopter was about 5 miles, and a round trip including loading and unloading, required 9 minutes. Six men, who were flown by airplane from Enterprise to Memaloose and by helicopter to Black Butte and took 1½ hours walking time, had only 3 hours travel time from point of hire to arrival at the fire.

The fire crew was supplied by air drop from a local airplane under contract, and William Maxwell, clerk on the Imnaha-Snake Ranger District, did the dropping.

Because of the desirability of quickly returning the smoke jumpers to their base, they were ferried by helicopter from the fire to the Memaloose airfield. Seventeen other men were also ferried to the Memaloose airfield but three of the local men preferred to take the long walk out. Most men although hesitant to make the first trip, soon enjoy riding in the helicopter and there has been no air sickness reported here from air travel in this machine.

We believe the helicopter to be a practical answer for transporting men to fires in the canyon country of the Snake and Imnaha Rivers and that both time and money are saved by the judicious use of this machine. Although we have had two near misses on accidents, we believe that, as the pilots get more mountain-wise and the machines improve, they are destined to play a more important part in fire control work.

Rust Preventive for Water Tanks

An experimental test of a commercial compound to prevent rust was recently conducted at the Michigan Forest Fire Experiment Station, Roscommon, Mich.

The results of the test would appear to have ended a long-time search for a satisfactory and economical rust preventive that could be used in the water carried or stored in fire equipment water tanks. The trade name of the material tested is "Banox."

Four small tanks made of 14-gauge, four-way floor plate (mild steel) were used in the test. One part of each tank was coated with Neutrol or Inertrol. Another part was coated with aluminum paint, and a control part was left untreated. Submerged in each tank was an equal amount of scrap steel, iron, brass, aluminum, galvanized iron, bronze, natural rubber, and Neoprene rubber.

Tank 1 contained plain tap water untreated (control tank); tank 2 contained tap water with 2-percent Drench and Banox; tank 3 contained tap water and 2-percent Drench; and tank 4 contained tap water and Banox (in recommended quantity).

Results of tests after 45 days were as follows: Inertrol coating, no damage in any tank; aluminum paint coating, no damage tanks 2 and 4, tank 1 rusted through, tank 3 large spots of rust; untreated iron section, no rust or damage in tanks 2 and 4, tanks 1 and 3 badly rusted. Heavy rusting and metal corrosion occurred in tanks 1 and 3 which had no Banox added to the water. Rusting occurred in tank 3 within the first 24 hours and in tank 1 within 48 hours.

Banox can be used for other purposes such as standby metal water barrels filled with heavy salt water concentrations. It is nontoxic and contains no acids, alkalies, or chromate. Two pounds is enough to treat 200 gallons of water. Cost is approximately $12 for one case of 12 2-pound cannisters, f.o.b. Pittsburgh. [From "Giv 'N Take," a leaflet published by the Fire Equipment Development Committee for the North Central States.]—E. E. Aamodt, *Engineer, Region* 9, *U. S. Forest Service*.

FIRE LINE FEEDING BY HELICOPTER

Carl C. Wilson

Assistant Fire Control Officer, Angeles National Forest

The increased use of the helicopter on forest fires brought the demand r a small vacuum container to transport hot food to workers on the fire ıe. Through a local war surplus dealer the Angeles National Forest obined a U. S. Army Air Force "vacuum vat" which, we believe, solves e problem.

This vacuum vat is actually a large thermos bottle with a wide-mouthed ɔening. It is all metal and will withstand considerable rough use, thus ɛrmitting dropping by helicopter at locations where the ship cannot fely land.

The unit, which has been purchased locally for approximately $15, has e following specifications:

ver-all height	18 inches	Weight, empty	37½ pounds
utside diameter	16 inches	Weight, with pans	45 pounds
side diameter (mouth)	13 inches	Contents, liquid measure	8 gallons

The vat may be obtained with either a stainless steel or enamel lining. he enamel lining, however, permits the transport of citrus fruit juices other acidic foods without affecting the taste. A set of three tinned ıns may be secured with the unit (fig. 1). These are equipped with hold-

Figure 1.—Vacuum vat with three tinned pans. F-463453

down clamps and a lid with handle. Each pan has a 2-gallon liquid capacity. Stacked in the vat the pans provide room for three varieties of hot food.

Best results are obtained if the vat is preheated by filling the thermos unit with boiling water and allowing it to set for 20 to 30 minutes. The pans may be used to cook the food. However, these units will probably last longer if ordinary cooking utensils are used. The hot food is then transferred to the oven-warmed pans, and these are inserted into the preheated container.

Field tests conducted on this forest in May 1948 revealed that the heat loss between the time the hot foods are placed in the vacuum container and when they are served to the crews a reasonable time later was almost negligible.

In one case a 20-man road crew was fed the following menu on the job: Spaghetti and meat balls, string beans, hot french rolls, coffee, and lemonade. The temperature of the spaghetti dish was 142°F. when removed from the oven and placed in the vacuum vat at 10:30 a.m. One hour and 40 minutes later the heat loss had amounted to only 4°. Coffee was placed in the thermos vat at 170°F. at 10:30 a.m., and the temperature at 12:10 p.m. was 160°. Heat loss for the other hot foods was consistently low. The lemonade in the enamel-lined vat, of course, remained cool.

A typical meal which can easily be served by means of the vacuum vat is one tray of stew, one tray of cooked vegetable, and a third tray of hot, buttered rolls. Coffee can either be stored in the vacuum vat or in 1- or 5-gallon thermos jugs. The meal is served on moisture resistant paper plates and eaten with paper or plastic disposable utensils.

Most any hot food can be served from this container. However, foods with a high moisture content tend to lose heat in storage. Examples of commonly used menus are:

(1) Weiners and beans
Stewed tomatoes
Hot rolls

(2) Swiss steak and gravy
Scalloped potatoes
Canned peas

(3) Ham and eggs
Buttered toast

(4) Scrambled eggs
Hot cereal
Buttered toast

In addition, this container can also be used to serve cold lunches. Prepared sandwiches, green salad, and a thermos jug of cold milk or fruit juice makes an excellent noon meal for fire fighters.

If two trays are used for hot food and the third for rolls, at least 15 men can be fed from one container. Twenty men can be fed from one unit if all three trays are used for hot food. Several loaves of bread and some butter can be delivered by helicopter to supplement the three tins of hot food in the vacuum vat.

To eliminate premature opening of the vats when several are brought to a large crew, each should be marked with a tag showing its contents. If possible, all of the crew should be fed at the same time so as to reduce the loss of heat caused by opening and reopening the container.

The key points to remember in using these containers are: (1) Preheat the container with boiling water; (2) heat loss occurs every time the lid is removed; (3) heat loss is less from foods with a high moisture content.

Hot food carried in these vacuum containers was first served to workers on the Echo fire line on the Angeles in July 1948. Food was prepared at Arcadia, trucked to the helispot at the road end, 6 miles away, and then flown to the fire line by helicopter, an airline distance of 1 mile and a vertical rise of 1,600 feet. Travel time amounted to 2 minutes as com-

ared to about 1 hour for foot travel from the end of the road. Hot dinners nd breakfasts were available to 55 men on the line in less than 22 minutes fter the food left the cook stove in the Arcadia barracks.

Hot food readily available by helicopter makes for better morale among ie men and increases line production. These modern tools also will tend) decrease the number of elaborate spike camps with the usual primitive, ıbor-consuming equipment and the temptation to camp at the water oles which may be some distance from the active perimeter of the fire.

The vacuum vat is an effective tool in getting hot food to crews on olated sections of the fire line. Heat loss from food in the container is lmost negligible up to 1½ hours under normal summer conditions which ıeans that surface transport could be used to carry the hot food in some ıstances. The success of this unit on fires indicates that it can also be used ı other fields of forest management, such as road projects and rescue ıissions.

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(*Continued on page* 28)

FOREST FIRE SCOREBOARD

JOHN C. BAIRD

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Public interest in fire prevention was stimulated by a scoreboard graphically portraying forest fire occurrence from day to day, which was put on public display throughout the fire season by the Rio Grande National Forest.

The scoreboard consisted of a base map upon which each fire was ›cated by a ½-inch bright red circle. Round-headed pins of different ›lors to indicate the size class of fires fastened a red ribbon at the fire ›cation. This ribbon led to a card at the side of the scoreboard on which as shown the cause of the fire, class of people responsible, and date of fire.

The theme CARELESSNESS was stressed for all man-caused fires, the ord being printed in red letters. A block at the bottom of the board corded the number of fires by carelessness to date.

The scoreboard was originally used during the annual Sky-Hi Stampede Monte Vista, Colo., when two identical exhibits of the board were placed well-located store windows. One scoreboard was maintained at the . S. Post Office in Monte Vista throughout the entire fire season. Ambrose ırkhart, Senior Clerk on the Rio Grande National Forest, was largely sponsible for the exhibit and the work connected with it.

The scoreboard has been instrumental in creating considerable local ıblic interest in fire prevention. An estimated 25,000 people saw the oreboard during the 1950 fire season, and many expressed surprise at e number of fires and the carelessness involved.

[The forest fire scoreboard described here is considered an excellent rest fire prevention aid. It contains the necessary elements to arouse ıblic interest. Units where a majority of fires result from carelessness will ıd this method of presentation valuable in keeping the public informed ı the local forest fire situation.—Ed.]

Identification Marking for Tractors

On large fires where a number of bulldozers are working in the same general cinity, it is often difficult for the cat boss, aerial observers, and others to identify e various pieces of equipment. This is particularly true when both Forest Service d contract equipment are involved, and the latter is owned by several different ncerns.

It seems that better control of machines would be possible if each carried a stinguishing letter or number which would be easily read for a reasonable distance, her on the ground or from the air. When the equipment arrives on the fire, it uld be assigned a letter or number, if it is not already adequately marked. Water se paint which could later be washed off, or black scotch tape 1 inch or more in dth would be suitable for such marking. A roll of tape could be included in fire s.—C. D. JACKSON, *Topographic Engineer, Region 5, U. S. Forest Service.*

Study of Portable Wood Chipper

The possible use of a portable wood chipper for fire hazard reduction work was scussed by Ed Ritter in Mechanical Fire Hazard Reducer, FIRE CONTROL OTES, April 1950. Since that time the Northeastern Forest Experiment Station d the Connecticut State Park and Forest Commission have made a cooperative ıdy of this equipment. The results of the study are published as Station Paper ımber 37 entitled "A Pilot Study of a Portable Wood Chipper" by R. H. Fenton d H. A. McKusick. It was found the chipper could be operated (including de-eciation) for $4.04 per hour. Production was approximately 195 cubic feet of ips per hour. Costs per 100 cubic feet varied from $1.77 to $2.45 depending upon e of chips produced. The full report can be secured from the Northeastern Forest periment Station, Upper Darby, Pa.—M. M. NELSON, *Division of Fire Control, ashington Office, U. S. Forest Service.*

BULLDOZERS FOR FIRE SUPPRESSION IN THE MOUNTAINOUS TERRAIN OF THE NORTHERN ROCKY MOUNTAIN REGION

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A plan of standard operating procedures for bulldozer operation in fire line construction has been developed for use in the Northern Rocky Mountain Region. The organization, procedures, and equipment set-up were based primarily on use in timbered and mountainous terrain. The same principles, however, should apply in most cases where bulldozers are used to construct fire line. The operation, as presented, will not always be possible because necessary equipment and skilled personnel are not always readily available. In such cases it is necessary, of course, to make the best use of the available resources and organize accordingly.

The plan presented here is intended to cover only the use of dozers in fire line construction and mop-up. The production figures presented for bulldozer fire line construction are not considered entirely reliable, but they are the best available at present. [1] Region 1 is now using a special form to record additional information on bulldozer fire suppression use and accomplishments.

Following is the plan of standard operating procedure as now used by Region 1 in mountainous terrain:

ADMINISTRATION

Planning

The use of dozers for fire line construction should be made an integral part of the over-all fire suppression plan.

Supervision

Dispatching

Know dozer areas.—The best available map should be used as a base for showing the areas in which dozers can be used.

Know location of available dozers.—This means all dozers within your area that can be made available for fire use. The following information should be listed for each dozer and kept up to date:

1. Make, model, and size of tractor.
2. Type of dozer attachment (angle or straight blade).
3. Does it have a heavy-duty winch?
4. Is it equipped with protector cab?
5. Available skilled personnel to operate dozers.
    a. Dozer foreman.
    b. Dozer operators.
    c. Dozer helpers.

Location of trucks for hauling dozers.—Kind and size.

Know road limitations.—1. Transportation map should show types of vehicles each road will handle. 2. Bottlenecks such as poor bridges, sharp curves, narrow sections of road, etc., should be clearly marked on transportation map.

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[1] Fire Control men using tractors for fire line construction may be interested in reviewing Equipment Development Report Number 13. "Comparative Performance of D-6 and D-7 Caterpillar Tractors Equipped with Hydraulic Angle Dozers". by Region 5, Arcadia Equipment Development Center, April 1948, published by U. S. Forest Service, Washington 25, D. C.

Flagmen.—Furnish when possible or when State law requires. This should serve e following purposes: 1. Safety factor. 2. Speed up travel time. 3. Lead flag-an should serve as guide.

Mechanic.—1. Arrange for as soon as posisble. 2. In addition to regular tools, portable electric welder is desirable.

Supplemental equipment.—1. Torches for burning out dozer line. 2. Water nay be available at site of fire). 3. Diesel fuel, gasoline, and oil. 4. Standard uipment for fire dozer (see "Equipment").

Know estimated travel time.—The following is a guide to be used for average uipment, operators, and conditions. These figures should be adjusted to fit known nditions.

1. Transports: a. Highways, mountain—20 miles per hour. b. Side roads, single track—8 miles per hour.
2. Roading bulldozer: a. On dirt road—4 miles per hour, including stops for greasing. b. Cross country—1 mile per hour.

Fire line production figures.—The following figures, based upon the estimates our most experienced men, are for line construction only, according to fuel type sistance to control, and do not include line holding or mop-up.

	Line production (chains)
ɔw resistance to control:	
100-man crew for 10 daylight hours	[1]300
2 dozers, D-4 or larger, for 10 daylight hours	500
edium resistance to control:	
100-man crew for 10 daylight hours	[1]150
2 dozers, D-7 or larger, for 10 daylight hours	175
2 dozers, D-6, for 10 daylight hours	125
gh resistance to control:	
100-man crew for 10 daylight hours	[1]50
2 dozers, D-8 or larger, for 10 daylight hours	75
treme resistance to control:	
100-man crew for 10 daylight hours	[1]20
2 dozers, D-8 or larger, for 10 daylight hours	40

[1] Based on pick-up fire fighters.

General.—Consider the use of dozers when a fire gets beyond the smokechaser ige if it is located in dozer area. However, remember it is just another tool to be ed in fire line construction under certain prescribed conditions.

The availability of adequate crews without dozers versus crews with dozers and e time required to get them on the fire must be considered in placing orders.

Do not dispatch large trucks over questionable roads. This can result in block-g all transportation for several hours.

Remember, a dozer is ready to go to work upon arrival on a fire, no matter how ng or tough the trip, provided it is properly serviced and fueled and relief opera-rs are available.

When possible, hire dozers with protector cabs, heavy-duty winches, and angle zers.

spection

1. Does the dispatcher have all the essential information to do an intelligent job of dispatching dozers to going fires?
2. Is the dozer and transport record, showing location, availability, etc., kept up currently?
3. Have dozers been dispatched and used on crew-size fires in dozer areas?
   a. If not, what is the reason?
   b. Where used; was such use effective?
   c. Was the Safety Code followed?
4. Was the line burned out and cleaned up as soon as possible?
5. Were adequate fuel and supplies kept on hand?
6. Were relief operators arranged for where needed?

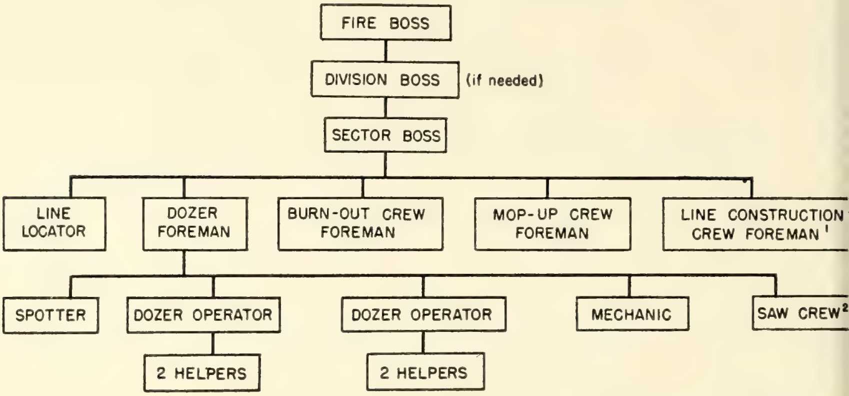
sts

After calculating manpower and equipment needs to control the fire within al-vable time limits, place your order accordingly. Do not duplicate line construction ganization by ordering both dozers and crewmen. This has been done all too often the past. The result is that in some cases the use of equipment has increased e cost of fire suppression without materially improving the performance. Adequate ews for burning out, line holding, and mop-up are, of course, essential for suc-ssful use of dozers.

Be reasonably sure that equipment can be used to advantage when it arrives a fire. Release equipment just as soon as it can no longer be used effectively.

Crew Organization

Crew organization is diagrammed in figure 1, and crew line-up on a fire i figure 2.



[1] For constructing hand line if necessary.

[2] Saw crew ahead of dozers if dozers are too small to handle full-length logs.

FIGURE 1.—Crew organization.

Communication

A complete communication network is a must on all large fires. Handie-talkie should be furnished the following dozer sector personnel:

a. Sector boss.
b. Line locator.
c. Dozer foreman.
d. Burn-out foreman.
e. Mop-up foreman.

PERSONNEL AND QUALIFICATIONS

Sector Boss

1. Good fireman.
2. Good organizer.
3. General knowledge of dozers.

Line Locator

1. Good knowledge of fire behavior.
2. Good working knowledge of the use of dozers on fire line constructio
3. Good woodsman.
4. Good hiker.

Dozer Foreman

1. Good fire foreman.
2. Good knowledge of dozers and the work they can perform; and the typ of terrain they can operate in.
3. Good organizer.
4. Must understand principles of fire behavior.
5. Must have sound judgment.
6. Must be able to make decisions.

Dozer Operators

1. Should be experienced in operating in timber and rough terrain. Experi ence on dozer operations on logging jobs, land clearing operations or pionee road work in timbered areas produces good operators.
2. Must be aware of dangers connected with this work.
3. Physically fit, mentally alert. Remember that a dozer is no better than th operator.

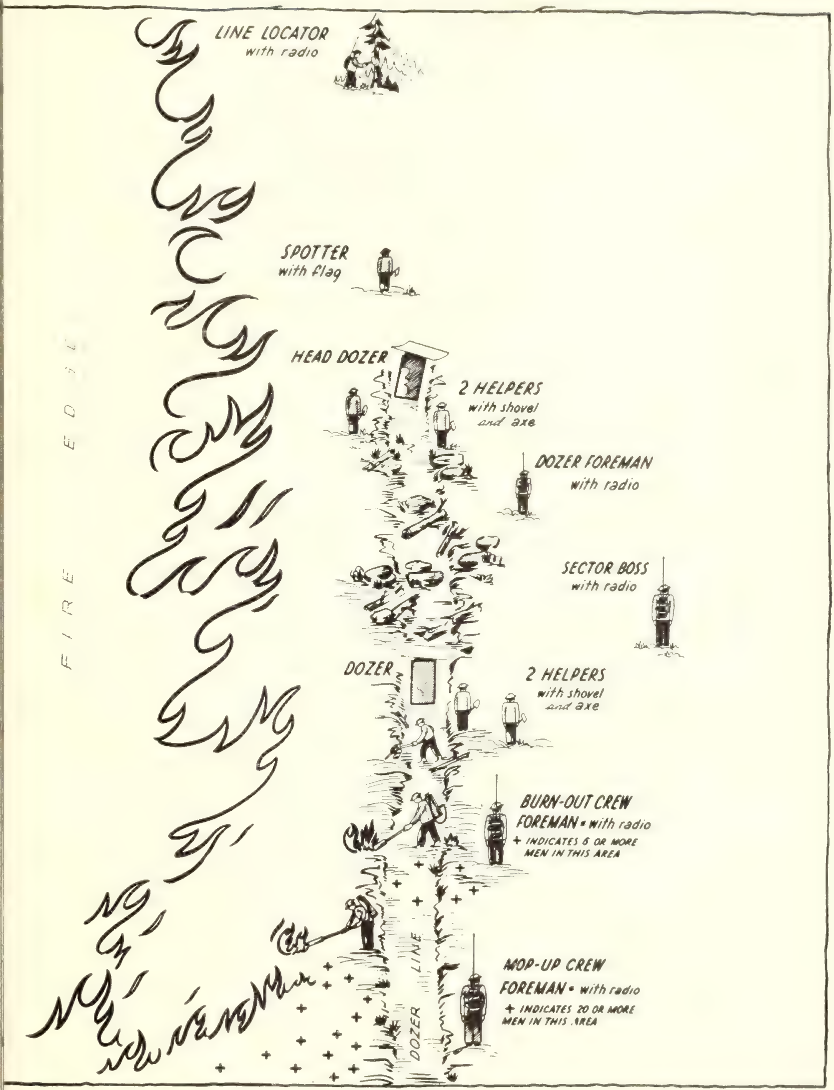


FIGURE 2.—Crew arrangement on fire line.

potter

1. Must understand the principles of line location and line construction.
2. Must know intimately where dozers can work without getting into trouble.
3. Must be physically fit, agile, and mentally alert; and should be able to recognize all the hazards of the job.

Extra operators may fill in on this job; but they should have rest periods between ne time that they are operating a dozer and the time they take over the spotting job.

It is essential that the operator have complete confidence in the spotter.

lechanic

1. Should be a tractor specialist.
2. Should be physically fit as it is quite possible that considerable hiking may be involved in a fire assignment.

EQUIPMENT

1. Dozers large enough to build fire line without saw gang in the lead shoul be used when available and it is possible to transport them to the fire within allow able time limits. Tractor dozer qualifications are given in table 1.
2. They should be lined up in units (two dozers) where possible.
3. Dozers with the following equipment are preferred as listed by priorities.
   a. Protector cab.
   b. Heavy-duty winch.
   c. Angle blade, quick change.
4. Supplemental equipment recommended with each dozer unit.
   a. Protector cab, each dozer.
   b. Heavy-duty winch on at least one dozer.
   c. Two axes.
   d. Two shovels.
   e. Two fire extinguishers.
   f. One each, 100-foot, ¾-inch cable.
   g. One each, 20-foot, ⅞-inch choker.
   h. Two each, single blocks.
   i. Extra control cable and cable cutter with each dozer.
   j. Crank for dozers without starters. Keep in secure place so that it can not be lost.
   k. First-aid kits.
   l. Hard hats for dozer crew.
   m. Wire screen, 3/16-inch mesh, to cover radiator grill to keep debris out thus avoiding heating.
   n. Protection for headlights. Items c to m inclusive can be made up int a dozer kit in advance and placed at a strategic point.
5. Fuel and oil. No amounts have been placed on these items as they will var with availability and estimated length of the job, but don't run short.
   a. Diesel fuel.
   b. Gasoline (starting motors).
   c. Oil
   d. Grease.
   e. Grease gun, bucket type.
   f. Water.

TECHNIQUES AND PROCEDURES

Transporting Dozers via Truck or Transport

1. If the load is overwidth (as in all the larger dozers), it is desirable to furnisl a flagman. This is mandatory in some States. See "Flagman." When available anc contacted, the highway patrol will usually act as flagman for emergency trips.
2. When applicable, obtain overwidth permit.
3. Dozers should be chained and blocked against both end and side movement
4. Transport driver should watch for the following:
   a. Overhead obstructions.
   b. Narrow sections of road and narrow bridges.
   c. Weak bridges—if in doubt unload and bypass where possible.
5. When feasible, include available supplemental equipment and supplies.
6. Place flagmen or flares on the road if it is blocked or partially blocked i loading or unloading operation.

Roading Dozers

1. On roads not suitable for large trucks.
   a. This will not hurt the tractor if the operator will check the lower roller and front idlers every 20 to 30 minutes for heating.
   b. At the first indication of heating (warm to the hand), the rollers shoulc be greased. If permitted to get hot, it will be hard, if not impossible, tc hold grease.
   c. If the tracks are run loose on long trips it will help to avoid heating.
2. Cross country off roads.
   a. This will be mostly in low and second gear.
   b. Choosing the best route.
      (1) Pick a local man (well acquainted with the country) to help ir deciding on the exact route to the fire.
      (2) Make use of aerial photographs.
      (3) May be desirable to scout possible route by plane or helicopter.

Sector Boss

1. Coordinate between dozer crew, burn-out crew, line locator, and other crews under his supervision. Be sure the line locator is doing a good job.

TABLE 1.—Tractor dozer qualifications

Tractor make and size	Weight (approximate)			Area track on ground, standard gage	Ground pressure per square inch	
	Tractor	Dozer and control unit	Total		Tractor only	Gross
	Pounds	*Pounds*	*Pounds*	*Square inches*	*Pounds*	*Pounds*
Allis Chalmers HD-19	40,000	[1]15,675	55,675	5,118	7.8	10.9
International TD-24	37,500	[2]12,838	50,338	4,598	8.2	11.0
Caterpillar D-8	35,950	10,365	46,315	4,389	8.2	10.5
Cletrac 120 FDLC	29,760	10,410	40,170	3,840	7.8	10.5
Caterpillar D-7	25,130	8,360	33,490	3,730	6.7	9.0
International TD-18A	22,570	10,650	33,220	3,385	6.9	9.8
Caterpillar D-6	16,725	5,765	22,490	2,740	6.0	8.2

Tractor make and size	Drawbar	Drawbar pull		Travel speeds				Over-all width standard tread	Ground clearance
		Low	High	1st	High	Reverse			
						Low	High		
	Hp.	*Pounds*	*Pounds*	*M.p.h.*	*M.p.h.*	*M.p.h.*	*M.p.h.*	*Inches*	*Inches*
Allis Chalmers HD-19	140	50,100	..	0-3.0	0-7.0	..	0-5.5	109¼	16⅛
International TD-24	148	35,500	[3]4,650	1.6	[3]7.8	1.6	[3]7.7	102	13⅞
Caterpillar D-8	130	28,700	[4]8,600	1.7	[4]4.8	[5]1.7	[6]3.0	103¾	10½
Cletrac 120 FDLC	120	28,600	[7]7,150	1.6	[7]5.0	1.6	2.8	100	19½
Caterpillar D-7	81	21,700	[4]4,270	1.4	[4]6.0	[5]1.6	[7]4.1	97	15½
International TD-18A	89	19,480	[8]4,780	1.7	[8]5.7	1.6	3.5	82¼	14
Caterpillar D-6	66	17,000	[4]3,620	1.4	[4]5.8	[5]2.1	[7]4.6	75¼	12½

[1] Garwood angle dozer.
[2] Isaacson angle dozer.
[3] 8th gear.
[4] 5th gear.
[5] Low reverse gears.
[6] 3rd gear.
[7] 4th gear.
[8] 6th gear.

2. Keep dozer crew to a minimum for two reasons: a. Safety. b. Men will n work effectively in vicinity of dozers, but are inclined to stand around watching tl dozers. Keep other crews out of immediate dozer areas for the same reasons.

3. Instruct burn-out crew to burn out and clean up line behind dozers as soo as possible. This is a must. The size of the burn-out crew will vary depending o fuels and burning conditions but must be adequate to do a good job.

4. Arrange to build by hand those sections of line not suited to dozer constru tion. Usually this is an early morning job with this crew, switching to line holdir and mop-up later in the day.

5. When there is a choice, be sure to order dozers large enough to build th fire line without the necessity of a saw gang in the lead. If a saw gang should b needed, do not overlook power saws. This crew is going to slow down the dozers s anything that will speed them up will step up line construction.

6. Communication. Radio communication, handy-talkies, with the following necessary for a smooth-running, efficient organization:

a. Sector boss.	d. Burn-out foreman.
b. Line locator.	e. Fire boss.
c. Dozer foreman.	f. Base camp.

7. Line up dozer foreman and line locator on type of fire line to be constructed

Line Locator

This man scouts and blazes line well in advance of the dozers. This is necessar so that desirable line changes can be made before the dozers reach the section i question. The general route marked must be negotiable by dozers.

1. Avoid wet or soft ground.
2. Avoid solid rock.
3. Avoid high-hazard or worse fuels because: a. They slow down line con struction. b. Line is harder to hold.
4. Avoid contouring on slopes over 45 percent. Above 45 percent dozers wi have to do some excavating to level up, which slows them materially.
5. Dozers cannot climb straight up slopes in excess of 65 percent.
6. Dozers can go down slopes up to 100 percent provided the going is good and the route is clear to the extent that they will not have to back up, a such a maneuver is, of course, impossible.
7. It is desirable that the line locator be equipped with an abney level.

Dozer Foreman

1. Decides on type of fire line to be constructed, based on instructions from th sector boss and on conditions on the fire line.

2. Types of line construction:
   - a. Direct.
     - (1) Generally use in grass and light fuels where heat from the fire wi permit working the fire line.
     - (2) Use when possible, where timber values in the area are high an loss from the indirect method would be high.
     - (3) Above the fire on slopes over 30 percent if the conditions permit The reason is that too much time is lost in working fuels uphil against the slope; and where fuels are pushed toward the fire, i is usually better to work in the fire where possible.
     - (4) When line will not burn out because of poor burning conditions This means that the edge of the fire would have to be worked eventually, so the line should be put there in the first place.
     - (5) Work inside the fire as much as possible to keep the volume o fuels to a minimum.
   - b. Indirect.
     - (1) Stay away from the fire far enough so that the dozer will not be in any danger of carrying any fire to the outside of the line when clearing the line and piling fuels on the side away from the fire.
     - (2) Allows the line locator and spotter to straighten the line and choose the easiest going. This speeds up line construction.
     - (3) This does require a burn-out crew to clean up the line immediately behind the dozers.
   - c. Backfire line.
     - (1) Used by specialists only in special cases on large, hot fires.
     - (2) Wide line is cleared from which to backfire in advance of mair fire. A dozer unit can do the work of several hundred men where a wide line is needed to make backfiring safe.
     - (3) Advantage is taken of favorable fuels and topography.

(4) Principles of locating line and setting backfire are the same as for a hand line.

d. Ditch line below fire on steep ground to catch rolling debris that might fire across a regular line.

e. General.

(1) Snagging. All snags that may possibly start spot fires or endanger men working on the line and on mop-up should be pushed down.

(2) Hot spots or potential hot spots. Dozers should be used to reduce these and scatter the fuels.

(3) When line conditions permit, in all cases other than direct method of line construction, throw debris away from fire.

3. Must keep the two dozers far enough apart for a safe operation, especially n snag pushing, so that one is always on good, safe ground in a position to help he other in case of trouble.

4. If some manpower is available, it often is good business to skip short sections f line that would materially slow up the dozers provided the dozers can bypass uch spots.

5. Be sure tracks are in proper adjustment. They should be fairly tight for side-ill work; this may necessitate adjusting tracks after roading a long distance.

6. Be alert for unsafe work habits—do not tolerate as this is a dangerous opera-ion at best. Be thoroughly familiar with the U. S. Forest Service Safety Code, articularly Sections No. 16, Fire Fighting, No. 39, Tractors, No. 40, Tree Felling, nd be sure that the operators are also familiar with these sections.

7. Have plans laid at all times for the safety and escape of crew and tractors n case of a blow-up.

8. Generally instruct lead dozer to break trail and get through in the shortest ossible time, not to worry about the kind or amount of work done. Go over top f windfalls, etc., where it is possible to do so safely.

a. Second dozer is to finish line. This does not mean a road; all that is necessary is width enough to get the dozer through and a line the width of a track pad to mineral soil. If some debris falls back in, it is cheaper and faster to have helpers clear by hand rather than to have the dozer back up for it.

b. The distance between the dozers will vary, depending on conditions. If held too close together the lead dozer will often hold up the second one. On the other hand, on hot burning fires it is necessary to keep the dozers close together and build a completed line. One of the most important jobs of the dozer foreman is to watch this and make adjustments currently.

c. Do not separate dozers except on rare occasions such as light fuels and easy slopes. If the dozers are separated instead of worked as a unit, insist on communication with each machine.

9. When working in grand fir or hemlock, caution operators to watch out for ound-looking green trees that are rotten in the center to the extent that they may near off, causing the tree to fall on the dozer.

10. Inform dozer crew that the operator has a full-time job in looking after imself and his dozer. It is the individual's responsibility to look out for himself nd stay in the clear at all times.

11. Arrange for relief operators if the job of line construction will continue or over one shift. Fatigue is a big safety factor on this type of work.

12. Signals must be set up in advance of starting line construction and must e understood by all members of the dozer crew. The following are commonly used. They are given by spotter or foreman.

a. STOP. Wave flag or light back and forth, waist high with swinging motion.

b. COME AHEAD. Up and down in front of spotter from the waist to arm's length above head.

c. TURN. Swing the flag or flashlight on the side to which the operator is to turn.

d. REVERSE or BACK UP. Full circle in front of the spotter.

e. CAUTION. Wave flag or light in a half circle at arm's length above head.

f. CAN'T SEE SPOTTER. Gun motor twice. Given by operator.

g. WANT DOZER HELPER TO COME TO DOZER. Gun motor once. Given by operator.

h. ATTRACT OPERATOR'S ATTENTION. One blast on a police whistle or other suitable substitute to attract attention. Given by helper.

13. Equipment and supplies.

a. Check to see that all necessary items for a successful dozer operation are available or on order. Remember that equipment and supplies can be de-

livered (dropped) by plane on short notice if other means of transportation spells delay.

b. Keep mechanic readily available in case of a break-down.

Spotter

1. Works under immediate supervision of dozer foreman. Spare operator is often used in this job.

2. Works directly in front of lead dozer, follows the general route blazed by the scout, and signals the operator the exact route. Uses a flag in the daytime and a flashlight at night.

3. Must avoid or warn operator of all hazards that the operator may not be able to see.

4. Make detailed location of the type of line indicated by the dozer foreman, and marked roughly by the line locator.

5. Give the dozer all possible breaks.
   a. Choose the best terrain.
   b. The lightest work.
   c. The shortest route consistent with good fire practice.

6. Spotter must be alert at all times and keep well out of reach of falling timber. Remember, this is the most dangerous job of all; be guided accordingly.

Dozer Operators

1. Job is to build a completed fire line.
2. When available two dozers usually work as a team.
3. Do not let both dozers get stuck at the same time.
4. Always be on the alert for dangerous snags or trees.
   a. The practice of "rocking" trees to push them over is generally prohibited. Too much danger of the top breaking off.
   b. Always ease into trees and snags. Feel them out before using full power to push them over.

5. You are responsible for an expensive piece of equipment, do not take foolhardy chances.

6. Diesel equipment is safer around fire than gasoline; but don't press your luck. Keep tractor free of excess oil and grease.

7. Be sure your machine is in good working order and proper adjustment. Report any trouble to the foreman at once.

8. When stopping tractor, always place the shift lever in neutral position and engage master clutch.

9. General:
   a. When the fire line has been completed and the fire controlled, it is usually desirable to keep one or more dozers available for a reasonable period as a safety factor.
   b. Dozers can be used advantageously on mop-up, especially in heavy fuels and snag areas, if used wisely. Indiscriminate use will increase the mop-up costs, hence this phase of the operation will require close supervision.
   c. Often dozers will pay big dividends in man-hours by improving the route into a fire and the fire line to the extent that 4 by 4 vehicles can be used in placing mop-up crews on the line. This is a dollar-and-cents matter and the cost of improving the line must be weighed against the anticipated gain.

OPERATING RULES

1. Know the Safety Code and live up to it.

2. Calked and hobnailed boots are not to be worn on tractors; composition soles are preferred.

3. No one shall ride on a dozer with the operator, except in the seat and under the following conditions:
   a. On business in safe areas.
   b. Roading in open going.

4. Dozers operating in dangerous, timbered country should be protected from falling tree tops, limbs, etc., by a suitable canopy over the operator.

5. Operators, dozer foreman, spotter, and dozer helpers must wear hard hats when available.

6. The operator shall never leave the dozer seat with the master clutch disengaged except in emergency.

7. No night operation will be permitted in highly dangerous snag areas.

8. Never get on or off a machine while it is in motion.

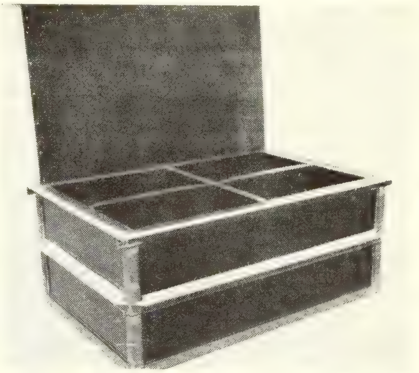
9. No one should approach a dozer except from a point in full view of the operator and after making sure that the operator has seen him.

EXPERIMENTAL PLASTIC WATER TANK

Arcadia Equipment Development Center

California Region, U.S. Forest Service

In an attempt to construct for fire trucks a water tank that is free from orrosion and long-lived, an experimental tank was designed by a leading ıanufacturer of rubber and plastic products. It was sent to the Arcadia quipment Development Center for testing.



The tank, in a steel frame as ıown, is fabricated from bakelite. he capacity is 125 gallons.

The tank was tested under condi-ons which could be expected of any ip-on tanker unit. It was found that fter limited testing the tank began leak around the base seam. Baffle late also pulled loose. The material the plates bulged but held up well, ıe seams alone being deficient.

Conclusions: Water tanks de-gned like the test unit, and fabri-ıted from the same material, are ot adequate for the rough treat-ıent to which fire trucks are subjected.

The plates, from which the tank was fabricated, appeared adequate. owever, it is doubtful that the material would withstand constant bend-ıg for a long period of time.

A more substantial method of cementing and reinforcing joints would necessary.

It is not advisable to construct fire tanks of material which will burn adily.

Too much support is necessary in the form of framework, which defeats ıe purpose of lightweight construction.

Tank was fabricated according to plans for steel construction. Possibly onstruction of a type more adaptable to the material would have pro-ıced a stronger unit.

Still Tying Rolled Hose?

The problem of tying cotton-jacketed, rubber-lined hose in rolls so it can be adily untied was solved for the Cleveland National Forest by Harry Whitney, sup-ession crew foreman. He cut rubber bands about three-quarters of an inch wide om discarded truck inner-tubes and stretched two of the bands at right angles each other over the roll. The rolls are securely held in place and can be quickly ırolled by pulling off the bands.—Stanley Stevenson, *Fire Control Officer, leveland National Forest.*

PLASTIC BALLS ON RADIO ANTENNA RODS FOR SAFETY

GUY V. WOOD, *Communication Engineer,* and ALBERT H. SCHOSS, *Communication Technician, Region* 5, *U. S. Forest Service*

The exposed and sharp tips on certain types of antenna rods or whips present a serious physical hazard and can be the cause of severe eye and face injuries.

Certain of the standard mobile antenna rods are supplied with either plastic or metal balls on the tips to reduce the physical hazard. Others such as the Motorola Model P-8253 roof-top mount type are not so supplied, possibly because the rods are originally manufactured and stocked in a single maximum length and are cut (at the tip end) to specified frequency lengths just prior to shipment to the user.

On the Motorola Handie-talkie radiophone Models FHTR-1AL and FH2TR-1AL the short-length whips as supplied have a closed loop formed of the tip end which prevents eye or face injuries. The loop is effective until the whip is caught in the brush or on a limb at which time the loop opens up in the form of a fishhook; it is then a constant hazard to the radio user and to fellow workers.

To overcome the above hazards a plastic (Lucite) ball may be heat-sweated on the ends of these, and other type rods and whips not specifically mentioned, by a simple process as follows:

Mounting the ½-inch plastic ball to handie-talkie type antenna whip.—

1. Cut off formed loop on the tip of the whip and file a point so as to provide a tip which will follow a straight course into the plastic.
2. With a knife remove about 1½ inches of the coating on the tip end of the whip.
3. File small notches 1/16, 1/8, and 3/16 inch from the tip end to provide a grip for the plastic ball.
4. Insert the antenna whip in a small vise with the tip extending out about 1½ inches. Heat the protruding tip with a 100-watt electric soldering iron. Do not use an open flame for this heating.
5. By wearing a leather glove it is now possible to slowly force the plastic ball onto the whip while still maintaining contact on the whip with the soldering iron. Avoid touching ball with the iron.
6. Do not make use of a drilled guide hole in the plastic ball, a more secure job results in not using one. It is not difficult to center the ball on the tip.
7. Run the tip of the whip well into the ball but not through it.
8. After cooling, remove the whip from the vise and apply Vinylite or equal plastic cement to the part of whip from which the plastic coating was previously removed. This is to prevent rust and corrosion.

Mounting the 5/8-inch plastic ball to mobile type rods.—

1. Remove, if present, the plastic plug as originally supplied in rod (i.e., in Motorola type hollow-rod).

2. With a knife remove about 1½ inches of the plastic coating from ıe tip end of the rod.

3. File notches 1/8 and 3/16 inch from the tip end of the rod to provide grip for the plastic ball.

4. Grind a point-shaped end on the rod tip to reduce the required ıstalling pressure.

5. Complete the operation by following steps 4 through 8 as outlined ɔr the ½-inch plastic ball.

Severe impact and shear tests run on these finished rods and whips have ıown no tendencies on the part of the Lucite balls to shatter or break ɔose.

As an additional feature, by installing these protective tips on the mobile ɔds the problem of hooking the rod down during periods of nonuse is reatly simplified.

These particular plastic balls, as used, are stock production items and ost only a few cents each. They are possibly available in most localities rom plastic hobby or supply stores.

Guiding the Fire Chaser

Recently I had an experience which gave me an idea for improvement. One day hen atmospheric conditions blended the ridges so one could not distinguish the ‹act location, I detected a tiny fire two districts away. The other lookout had been ken down so there was no cross reading. I called Fire Control Assistant Nelson one of Camptonville, Tahoe National Forest. He got on a ridge known to me ıd flashed a mirror, and I directed him from there to the fire. The fire was kept ı A size even though it was on the district beyond Camptonville.

Now here's the point: 15 minutes later the sun was gone and we could not have ceived his flash. If we had a *small powerful light* for this purpose, we could prevent ts of trouble in the future. Sounds logical, doesn't it?

The vertical reading couldn't be taken because of old-fashioned windows with oss bars. [In some regions a gasoline lantern has been used for the purpose deribed.—Ed.]—MRS. MARY GORMLEY, *Lookout, Tahoe National Forest.*

Tape Guards for Edged Tools

Use two thicknesses of masking tape or adhesive tape folded over the cutting edge axes, pluaskis, etc. The tape stays on and does not need to be removed to use ols; a few blows cut it free when tools are needed. This safety measure does not terfere with carrying axes in the spring clips on pickups and trucks. The white rip shows up well on the cutting edge of tools at night, an important feature for ews in rough country at night.—CARL O. PETERSON, *Fire Prevention Aid, San ernardino National Forest.*

AN EFFICIENT PORTABLE RADIO AIRPLANE ANTENNA

Roy L. Weeman

Communications Officer, Region 2, U. S. Forest Service

A review of previous antennas for use with portable radios in airplanes indicates very poor radiation efficiency. In most instances they have consisted of end fed wires of random lengths. Such antennas will not properly

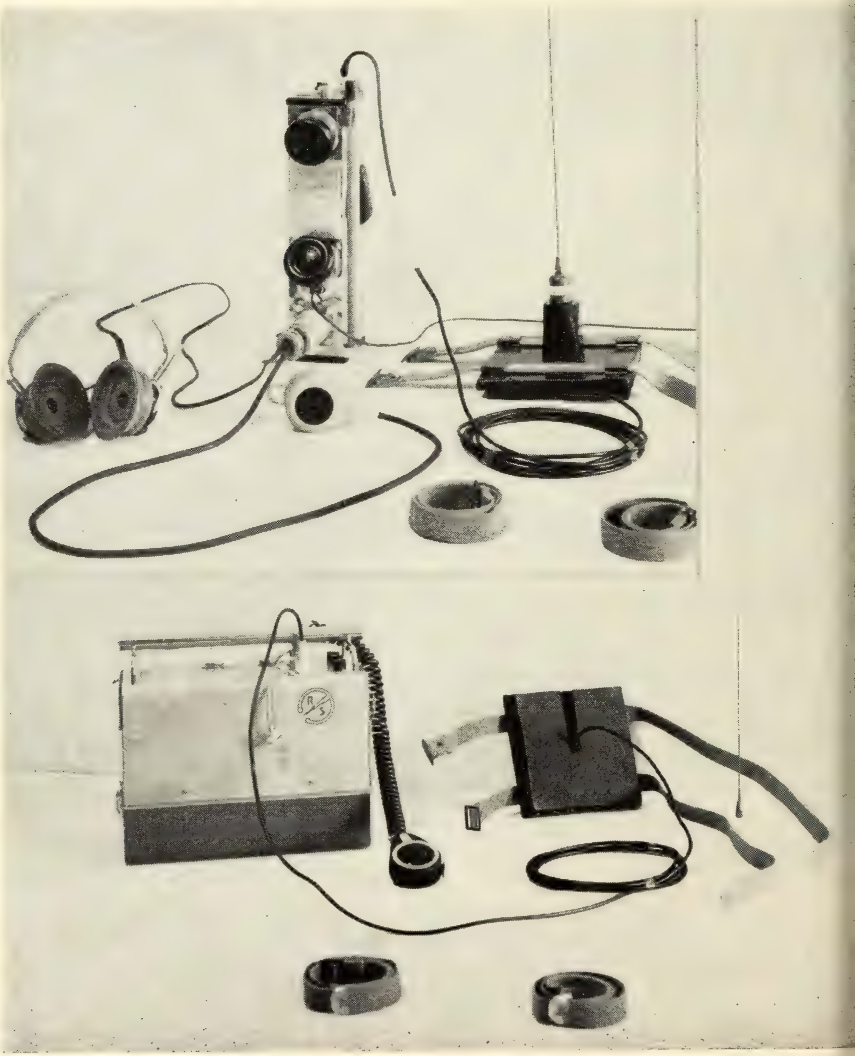


Figure 1.—*Top,* plane antenna with SF model "C" handie-talkie attached; *bottom,* underside of antenna base with pack set attached.

match the transmitter terminating impedance and therefore greatly decrease the energy radiated from the antenna.

This antenna consists of a 43-inch whip properly base loaded to satisfactorily match 50- to 100-ohm coaxial cable. In our installations we have used RG58/U 53-ohm cable, but if a more rugged installation is required, heavier coaxial cable such as RG8/U 53-ohm or RG11/U 75-ohm cable may be used. The antenna whip and loading coil may be purchased for approximately $5 from a leading manufacturer of radio equipment. The loading coil is available for frequencies from 25 to 40 megacycles.

The whip and loading coil are mounted in a hardwood block, 2 by 2 by 4 inches, which is secured to a plywood base, 7 by 7 by ½ inches, with 2-inch wood screws. Web straps are passed through keepers mounted on the top of the base to permit attachment to suitable parts of the airplane (fig. 1). Additional web straps are furnished to secure the lead-in between the antenna, which is located as far from the fuselage as practicable, and the cabin of the plane. The lead-in is attached to the loading coil through a hole in the base and can leave the antenna in a collinear or perpendicular direction. Sponge rubber, ½ inch thick, is cemented to the base to prevent damage to the plane. A slot in the rubber permits the lead-in to leave the antenna at right angles. The lead-in can be any suitable length to serve the various airplanes which may be used. An adapter fitting near the end of the coaxial cable permits the antenna to be used with the pack set, SF model "C" handie-talkie, or the Motorola handie-talkie. The unit assembly may also be readily adapted for emergency mobile use in cars, trucks, and pickups to serve the same radiophones.

When the antenna whip is perpendicularly mounted, excellent results are obtained in excess of 20 miles, with practically a total absence of dead spots. Reports from one region indicate satisfactory operation up to 80 miles when the airplane has sufficient elevation to obtain line-of-sight transmissions.

[Aircraft operators must obtain CAA approval on installation of equipment of the character described in this article. Refer to Part 15, Aircraft Equipment, Air Worthiness, Civil Air Regulations.—Ed.]

THE POLAROID CAMERA IN FIRE CONTROL

CARLOCK E. JOHNSON, *Forester, Sequoia and Kings Canyon National Park,* and LEON R. THOMAS, *Assistant Supervisor, Sequoia National Forest*

The recent development of a new type of camera, the Polaroid land camera, manufactured in Cambridge, Mass., has added many possibilities to the use of photography in forest protection. During the 1950 fire season the authors conducted experiments with this camera to determine its value in fire control.

In making the tests one idea was paramount. That was to record vital fire data and to make it available for ground crews in a matter of minutes. These data would include location, relative size of the fire, topography, fuel type, areas of probable spread, wind direction, logical points of attack, and if possible routes of access to the fire. This can be done by means of aerial photos taken with this camera and dropped to ground crews.

The most significant feature of the Polaroid land camera is the fact that a picture can be taken and developed in this camera, on the spot, within a period of 45 seconds to 3 minutes, depending primarily on the temperature of film at the time of development.

The basic camera with exposure meter costs approximately $100. Additional accessories are not necessary. Black and white film costs approximately $1.70 per roll of eight pictures; the pictures are 2¼ by 3¼ inches. The camera loaded with film weighs 4½ pounds. The exposure meter adds another ¼ pound. The over-all size is 9½ by 5 by 2½ inches. Carrying cases for convenience of handling and protection of the equipment are available.

The camera is built for speed and ease of operation. The aperture and speed of the lens are adjusted in one operation and are calibrated in numbers which correspond to the numbers on the polaroid light meter. This makes for simplicity and eliminates the chance of error. The correction for distance is adjusted separately.

After exposure it is necessary to push a button, pull out the film strip, wait the required developing time, then open the back of the camera and take out the finished picture. As with all cameras, a little experience is necessary before one can consistently take good pictures.

Pictures of a going fire are of greater value to the fire boss if they show the conditions at the time of examination. Aerial pictures can be taken with this camera and dropped to the fire camp in a matter of minutes (fig. 1). Combined with observers notes, written in grease pencil on the picture, or by air to ground radio communication, the fire boss or planning officer can quickly and accurately interpret the information.

Heavily timbered and rough terrain often causes delay in locating small fires. In some instances this has resulted in major fires or expenditure of badly needed man-hours. A picture, dropped from a plane, can make this task much easier for the footsore smokechaser.

Lightning storms ofter cause numerous small fires, requiring simultaneous action by the dispatcher. An observer in a plane can easily photograph each

FIGURE 1.—Eagle Peak fire, Sequoia National Forest. Picture taken at 10:54 a.m. about 2,000 feet above the fire. Within 4 minutes after exposure this picture was dropped to the fire boss.

fire at the time of detection or reconnaissance. Decisions as to priority of strength and attack may be largely influenced by the data recorded in the photograph.

Experienced peace officers are well aware of the need to safeguard "Chain of Custody" in handling evidence for submission to courts. This is particularly true in photographing evidence. This camera enables the investigator to act as sole agent in exposing, developing, and submitting photographic evidence. It also ensures the recording of the actual information desired.

There was one serious weakness in the camera used in the experiment—the low shutter speed. A plane is often subjected to turbulent air which, combined with traveling speed, sometimes prevents clear, detailed pictures. Substitution of a faster lens should eliminate this fault.

Areas containing concentrations of smoke do not lend themselves to detail photography. It is believed that this camera will function as well as any other should this arise. However, it probably could not compete with infra-red type film.

Polaroid film does not furnish a negative. Therefore additional prints can be secured only by a number of exposures or by copying the original print. At present only two types of film, "sepia" and "black and white," are supplied by the manufacturer. The "black and white" type is the only one recommended for use in fire work.

The Polaroid camera is not intended to replace the foot scout or the trained aerial observer. It is not foolproof, nor will it meet all needs that may arise. However, it will give on-the-spot factual data and certainly has a place in fire control.

VOLUNTEER FIRE PREVENTION CLUBS IN OKLAHOMA

WM. MITCHELL

Assistant Forester, In charge of Fire Control, Division of Forestry, Oklahoma Planning and Resources Board

Organized volunteers in Oklahoma are handling fire protection with marked success. Since 1948, an unusual record has been made in the development, use, and response of volunteer help in the prevention and suppression of woods and range fires. This has taken place in the upland hardwood type of northeastern Oklahoma, an area of open range with most of the land in relatively small private holdings.

This idea of organized volunteers came from local people. It goes back to a rural mail carrier, Mallay Douglas, who in 1926-28 conceived the idea that community people should do something about stopping woods fires. He preached and talked this idea as he followed his mail route around Sugar Loaf Mountain in Arkansas and Oklahoma.

This idea was slow to take. Finally, one key person became interested in keeping fires off the Mountain. This spread to two and four, and more, until the majority of the community had joined the volunteer forces. Mr. Douglas later got the Bell Telephone Company to contribute enough salvage wire, as a public service, to reach around the Mountain. Volunteers developed with this wire a telephone network for use in warning of fires and in rounding up suppression help.

Communities in northeast Oklahoma became interested in this idea of the Sugar Loaf volunteers. At the start, progress was slow. Two communities in Cherokee County were organized in the fall of 1943, but only after a summer fire had wiped out 14 sections of woods range. The two communities banded 138 members together to protect 54,000 acres of range and woodland. Assistance in organizing was given by the Oklahoma Division of Forestry and County Agent Back of Cherokee County.

Two more groups were organized in 1944. But from 1944 to 1948, progress was poor. By the end of 1948, however, after State personnel had become available to assist in the organizing work, the groups had increased to 22. By March 1950, the number of groups had jumped to 76, containing nearly 1,300 members. Thus, volunteer interest has mushroomed and is now getting ahead of the number of State personnel available for organizing. These volunteers have become a real value in protection work in northeast Oklahoma.

Volunteer protection is a community undertaking. The people band together to form a "prevention club" that is made up of the majority of residents in a community. The Division of Forestry assists in organizing the club, which elects its own fire chief and assistant fire chiefs. All club members sign a Division of Forestry pledge card to prevent fires and to help in fire suppression. Each member is appointed a State Forest Guard and is given an attractive certificate. A supply of State hand tools is assigned

to the fire chief. When a fire occurs, the fire chief rounds up the members, gets the tools to the fire location, acts as the fire boss, and makes reports covering the fire.

The volunteer groups give protection beyond the area owned by the members. In the State ranger district at Sallisaw, for example, the 818 members in the 51 prevention clubs own 88,448 acres of land. However, these clubs extend protection to nearly 400,000 acres. The area protected by a club is "blocked in" as much as possible to join the boundaries of any adjacent club.

So far, action on fire suppression by the clubs has been good. In calendar year 1949, 45 fires burned nearly 12,000 acres, or 0.8 percent of the whole 1.5 million acres under volunteer influence in northeastern Oklahoma. Suppression assistance by the State is quite limited. Detection now is done by local people, but a State-operated tower system is being installed. Limited State tractor-plow support is given to the clubs when "back up" is needed.

How the suppression action by the organized volunteers will hold up in the future still is a question. Present indications are that the interest will continue. The State intends to rely on the suppression work by the clubs until it is proved that the volunteers are unequal to the task.

The biggest contribution the clubs make is on the prevention of range and woods fires. Carelessness with fires within a club area has become unpopular. In fact, most of the fires handled by the clubs have come from outside club boundaries. People within a club area who desire to burn over their own land are permitted to do so, provided the fire does not escape to the land of neighbors.

It is possible that fire prevention clubs, as now existing in northeast Oklahoma, can be developed in other States. With this thought in mind, essential points on the organizational work in Oklahoma are listed as follows:

1. Key people to provide leadership in support of volunteer community fire protection must be recruited and "sold" on the prevention of range and woods fires, if they are not already so inclined. The key people "work up" interest of other members of the community until a nucleus has been developed. This group then requests State assistance in organizing a prevention club.

2. The "selling" of community leaders in Oklahoma on the need for preventing range and woods fires has been a job done jointly by many men and many agencies. County agents, Extension Service, Soil Conservation Service, vocational agriculture teachers, Oklahoma A&M College, the Oklahoma Division of Forestry, the State Department of Agriculture, and others have joined hands to put this idea across from many viewpoints. Personal contacts, group meetings, demonstrations, contests, radio and newspaper programs have been the major approaches used. Only through the cooperation of the many agencies has this work been successful.

3. After a community group of 10 or more expresses interest in organizing a prevention club, representatives of the Division of Forestry meet with the local people to discuss the idea thoroughly. The community group then decides whether it wants to form a club or not. When the group decides to organize a club, members are signed up, the area of responsibility and the functions of the club are outlined. In this organizing work State personnel who have ability to meet with and get along with rural people are of utmost value.

4. After a prevention club is formed, State personnel assign a good supply of hand tools and provide a well-designed, weatherproof tool box. Monthly visits to each club also are made to discuss problems with the fire chief, circulate new ideas, prod or stimulate the program wherever necessary, give training in fire prevention and suppression, and show interest in community work and activities. Movies and talks are given frequently. Much "night work" is necessary. These follow-up visits are of great importance in keeping the volunteer groups alert and interested.

In conclusion, organized volunteers in Oklahoma will respond to outside help and interest in community problems. Their effort on prevention and suppression of range and woods fires more than pays for the effort, time, and money involved in the organizing work. Further information on the operation of the Oklahoma prevention clubs can be obtained through State Forester Stauffer at Oklahoma City, Okla.

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(*Continued from page 7*)

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"HOT SHOT" CREWS

STANLEY STEVENSON

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Scouting revealed that the head of the Burma Fire of 1949, Cleveland National Forest, was spreading rapidly uphill through medium to heavy brush and would reach the rim of an adjacent watershed unless checked on a small ridge ¼ mile from the top. One "hot shot" crew under Foreman George McLarty, San Bernardino National Forest, had been working the northern flank from the bottom and would reach the top too late to effect the check. The Cleveland "hot shot" crew Foreman, Leon Ballou, and 4 men were flown via helicopter from the southern flank of the fire to the ridge at the head of the fire. The 5 men hurriedly cut a line in front of the fire, backfired it out and started a direct attack on the fire edge down the south flank to meet the rest of the crew. The crew on the northern flank meanwhile had pushed through and tied to the northern end of the fired out line. Although numerous spots occurred and the crews lost the south flank twice because of whirlwinds, they closed the gap and effected control on a 280-acre fire that would probably have more than tripled its size within 4 hours unless the check had been made and the lines tied together.

Since these crews are trained to subsist on the line with bare essentials, a sustained push taking advantage of lulls in fire intensity is possible. This was demonstrated by the San Bernardino "hot shot" crew on the Agua Tibia Fire of 1950.

Lightning started this fire in very steep to precipitious terrain covered with medium to extremely heavy 80-year-old brush and scrub oak. The east flank of the fire had slopped over the planned control ridge approximately ½ mile from the top of the main divide. Helicopter scouting at 10:30 a. m. revealed that if the slop-over could be controlled the lines being constructed from the top and bottom along the flank would probably control that side of the fire.

Foreman McLarty was flown by helicopter around the slop-over and he then jumped about 6 feet to the ground inside the burn above the slop-over. He subsequently cleared a landing spot and 4 additional men were flown in to begin work on the line. Meanwhile, the rest of the crew were started down the ridge top along an old trail. Helicopter coverage guided the crew to their destination where they split forces and started around the slop-over. Although this action was completed within 1½ hours after the initial scouting, the slop-over had spread to a perimeter of approximately 65 chains on a very steep rocky slope in medium to heavy brush oak type.

McLarty and his whole crew worked until dark. They were sent food, lights, and blankets by helicopter. The crew was fed and rested in relays until a "scratch" line was constructed around the slop-over about 11:00 p. m. Early the following morning, the crew was again serviced by helicopter and the fire line finished and mop-up started.

Stubborn aggressiveness on the part of this crew prevented the fire from crossing the drainage and establishing a new head on even more precipitous terrain.

These two examples illustrate the flexibility of "hot shot" crew action. Similar action has been taken many times during the past 4 years. Control possibilities such as these would have been impractical without well organized, trained, and conditioned crews.

One of the "hot shot" crews has been based during the fire season on the Cleveland National Forest. The following notes, although concerned primarily with the Cleveland "hot shot" organization and operational procedures, are representative for "hot shot" crews in the California Region.

The crew is composed of young men whose primary requisites are physical fitness and a will to work. Their lack of experience and conditioning are compensated by intensive training in fire line construction and use of hand tools and fire hose lays at the beginning of each season. These men are termed "fire fighters" and receive fire-fighter rates of pay while on a fire. When not engaged on fire suppression they are paid laborer wages and used on forest projects.

A subforeman or straw boss works with and has charge of from 5 to 8 fire fighters. The straw boss is an integral part of each crew and takes his days off at the same time as the crew. Two assistant foremen acts as crew bosses and are each assigned one-half the straw boss squads. One of the crew bosses is capable of assuming temporary charge of the whole crew during the absence of the foreman.

The crew is under the direct supervision of an experienced fire fighter who can act, as one foreman put it, "from general to father confessor." This foreman must be a skilled leader, fire-wise, and physically fit for very arduous work. He usually assumes the duties of sector boss on fires.

Crew members are hired only after full understanding and acceptance of the rigid rules set up. Camp routine is fashioned after that of athletic training camps with scheduled hours for meals, work, recreation, and sleep. Although some men quickly drop out of the crew because of the difficulty of the job and the rigid dicipline, three have returned each year since 1947 and ten others including the foreman have been on the crew for the past 2 seasons.

Conservation, wildlife, general forestry, and training films give the reasons for the "why" and "how" of forest fire protection. The crew is given instruction in the use and care of fire line hand tools, followed by intensive work-outs on practice fire lines. Several afternoons during the first part of the season are spent on illustrative lectures, orientation, fire behavior, safety, and correct fire line construction practices. Action on early season fires is discussed on the ground with a large part of the constructive comment coming from the crew members.

After several successful attacks on early season fires, crews begin to develop an esprit de corps and an eagerness to prove their ability. Several distinctive arm patches have been designed and worn by crews hailing their identity. The competitive spirit on large fires requiring more than one crew has provided additional incentive toward better production.

The following summary of work accomplishment, although reflecting considerable more suppression time during the heavier fire season of 1950, indicates the advisability of preplanning and budgeting forces primarily for fire suppression.

Cleveland crew activities:	Percent of total man-hours payrolled 1949	1950
Training	12.6	6.6
Project work (nonfire)	10.7	17.1
Fire suppression	48.6	62.6
Headquarters camp maintenance and operation, cooks, and annual leave	28.1	13.7
	100	100

A sample of fire line construction rates by direct attacks on fire perimeters in Southern California vegetative types, computed from the data recorded on the ground by the Cleveland crew foreman and including rest periods, lunch time, and delays due to lost line, is given in table 1. Comparable line construction rates are difficult to evaluate since the "hot shot" crews are generally placed on lines where untrained or unorganized crews would make very little if any progress.

TABLE 1.—*A sample of fire line construction rates by the "hot shot" crew, Cleveland National Forest*

Cover type	Condition of crew	Time	Character of fire edge	Slope	Men	Fire line built: Total	Fire line built: Average per man-hour
					Number	*Chains*	*Chains*
Medium to heavy brush	Fresh	Day and night	Hot	Moderate[1]	23	74	0.21
Chamise	do.	Day	do.	Steep	26	135	.86
Medium brush	do.	Night	do.	do.	28	40	.35
Heavy brush	do.	do.	Moderate hot	Moderate[2]	20	23	.23
Chamise	Tired	do.	do.	Steep[3]	12	41	.34
Chamise and brush	Fresh	Day	Hot[4]	do.	38	23	.30
Medium to heavy brush	Very tired	Night	do.	do.	42	65	.25

[1] Scattered scrub oak stems.
[2] Very steep ½ mile hike to line.
[3] Some mop-up, rocks, cliffs.
[4] Line abandoned two times because of flare-ups.

The value of a trained unit of men that can be sent into difficult sections of a fire perimeter with a high degree of certainty that control will be effected, has been demonstrated many times during the past. The ever increasing demand for "hot shots" when the going gets rough is the fire manager's endorsement of the "hot shot" program.

JEEP PLOW

E. E. Aamodt

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Recent tests of the jeep and the Newgren-Monroe hydraulically controlled fire plow, conducted in cooperation with the State of Michigan at Roscommon, demonstrated that performance could be improved if the required drawbar pull could be reduced.

Therefore modifications of the plow were made which brought down the drawbar pull requirements more than 50 percent without greatly reducing the width or effectiveness of the fire line (fig. 1). Also, a small change was made in the plow lift lever arms which allows the plow more freedom to follow rough ground and gives the plow about 6 inches higher lift needed for clearance over obstacles and high road centers. The latter is especially important when the jeep is equipped with a tank and carries a full load of water.

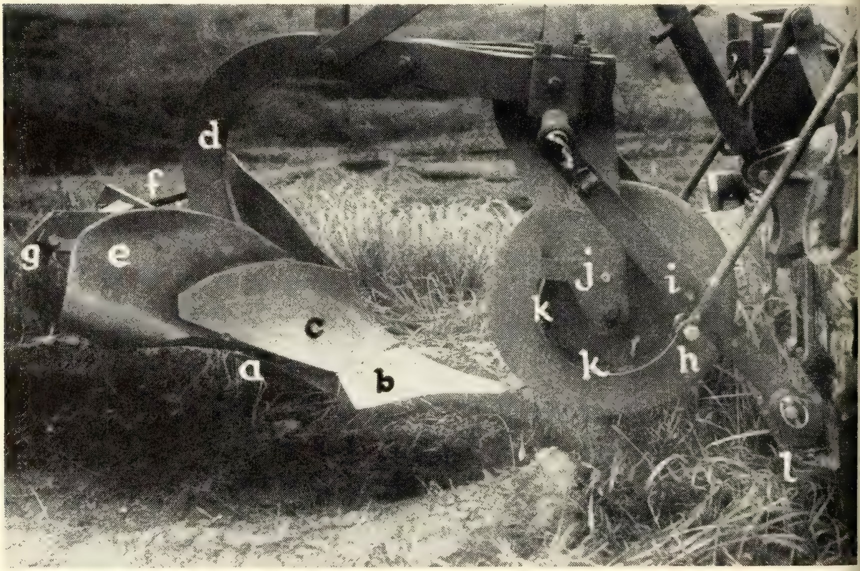

Figure 1.—Details of the modified jeep plow: *a,* Turf knives attached to middlebuster share after disks have been removed; *b,* Newgren middlebuster share; *c,* standard moldboard; *d,* plow beam; *e,* moldboard extension, spot welded to *c,* top loading part curved forward to prevent slip-over and bottom part curved to rear, to push and press down the furrow slice; *f,* extended moldboard brace; *g,* part of commercial plow to which disks were attached; *h,* bracket, with a hole, welded on brace bars to allow higher lift; *i,* old hole and mount for lever arm; *j,* second hole drilled to raise coulter in stony country; *k,* depth control flange, on each side of rolling coulter; *l,* implement drawbar, lowest part of rear of jeep.

The turf knives are the most important part of the modification of the eep plow. They cut the sides of the furrow slice clear of roots and permit t to be moved up and over into the wheel tracks. A clean furrow with- ut fall-back is the result of the use of properly positioned turf knives fig. 2).

FIGURE 2.—Clean furrow made by the modified jeep plow.

The knives are made up of a single piece of mild steel ¼ by 4 inches. Velded to the knives are two pieces of angle iron 4 by 4 inches having two oles for bolts that are bolted to holes already drilled into the bottom of he plow beam (fig. 3). The knives are heat-treated and hardened with compound called "Speedit," and are very abrasive resistant.

The modified plow makes a furrow averaging 19 inches wide, with fur- ow slice of 13 inches on each side, or an over-all line approximately 45 nches wide. This compares with a 27-inch furrow and 54-inch over-all ine width made by the Newgren disk plow when a complete line can be nade.

The modifications of the Newgren plow are simple to make and the total ost of materials and labor is about $25. The unit parts could be assembled n kit form and the actual installation made in any shop having an electric velding unit.

Tests made in typical jack pine-oak type gave comparative drawbar pull equirement of 1,238 pounds for the plow without modification and only 382 pounds for the modified plow. The traction and power of the jeep

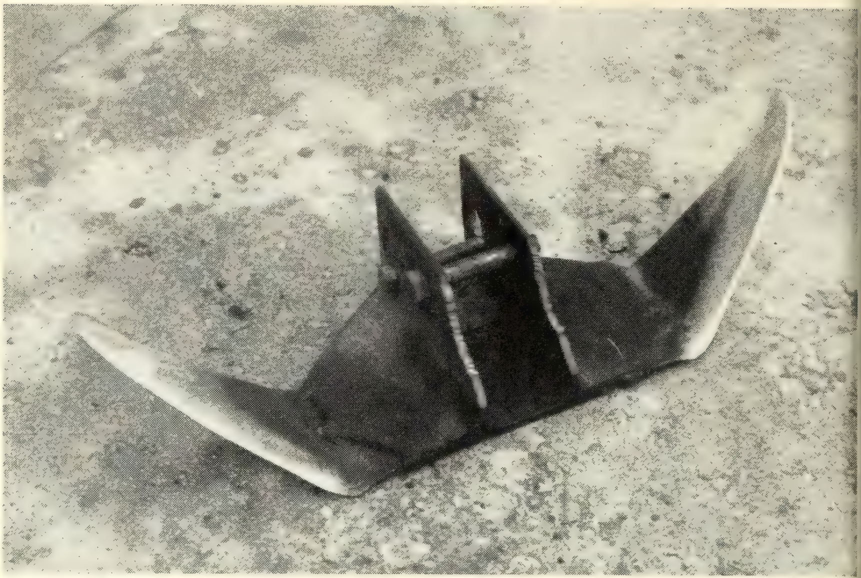

FIGURE 3.—Set of turf knives for modified jeep plow.

were adequate to pull the modified plow in the low, intermediate, and high gear shift range where it was impossible to make a satisfactory line in low gear with the unmodified plow.

The modified plow extends very materially the use of the universal jeep for fire suppression. This plow could be used with any four-wheel-drive vehicle. With increased traction and power, larger moldboards could be used to make wider fire lines.

IANAGEMENT OF FUNCTIONAL LINE MEN ON FIRES

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There must be developed, through thinking and then acting, a fluid type f suppression organization which permits the best qualified attack men ɔ always follow and be on hot fire fronts, has their places on controlled ne taken over by men most efficient in holding and mop-up, and develops iore supervisory working capacity from the local people for the holding nd mop-up phases.

In order to reach these objectives and to become more efficient on each roject fire we need to take a fresh look at the procedures used in present-ay organizing for suppression. How should our presuppression program e reoriented in order that top management, assisted by plans and service affs, can direct the suppression forces accordingly.

These thoughts are not new—rather they have been submerged, to a egree, by the rush and complexities involved, particularly on larger fires.)rganizational thinking, along these lines, is not pronounced because the iggest job is to select and train men to fill positions in the over-all sup-ression organization and then to control the fire.

On all large fires there is a tendency to act from thinking in terms of ɔtal size and peremeter. More emphasis has been given to total quantities ather than to their component parts. Organizing has been geared to the ɔb of line building without breaking apart the free burning, holding, and ɔld sections materially and reorganizing accordingly.

As every fire progresses the critical portion of its perimeter becomes less ercentage-wise even though the distance around the running front in-reases. During one or two burning periods this front becomes pretty well abilized as to length of open line, after which it decreases until control effected.

We work hard at the job of selecting and training men to fill functional ne and plans and service phases for the required organization. Attention given down to the last details. Now let us consider and point up the two ıost critical phases of the line suppression task: initial attack, resulting in ɔntrol; and holding and mop-up, which makes for security.

Selection and training produces men best qualified to fill all of the func-onal line supervisory positions at different management levels. It should lso be used to classify men best suited for initial attack and mop-up, for res continue to spread because of lack of initiative and aggressiveness in ttack and control, and they are also lost as a result of lack of methodical etail in holding, mop-up, and patrol. Thus, the inherent characteristics nd capacities of men, along with selection and training, should bracket ıem to phases of work where their time and energies produce most effi-ently.

In all probability we could do a great deal more in developing supervisory orking capacity from local cooperators and population if we concentrated

on holding and mop-up training and assignments. It is believed, by and large, they could assimilate and become proficient in this phase much quicker than in the more complex job of initial attack.

To create a fluid type of organization, keeping in step with changing management objectives—i. e., from initial attack and control to holding, mop-up, and patrol—means the manipulation, by shifts, of overhead, according to their qualifications to a much greater degree than is presently done. Top management assisted by the plans section can keep attack and control men continually moving to the hot fronts. These men would normally be regular administrative and protection personnel. Their places on controlled line would be taken over by men most qualified to direct holding, mop-up, and patrol. Through an aggressive program of recruitment, training, and regular assignment these positions could well be filled by cooperators and other local people.

It is believed that, using this approach, the recognizing of so many chains of open, holding, and cold line respectively along with the types of men best suited to those kinds of jobs, we will not have to make so many calls for outside help. At least, wholesale requests for overhead would be tempered to quite a degree, depending on the job estimate, i.e., open, holding and cold length of line.

Each forest should examine its own manpower resources inside and outside the Service. Decide what portion of each suppression job should normally be done locally. Think through the needs over and above that. Plan for aggressive and intense attacks on open fronts with attenuating but methodical strength behind. Phases needing emphasis to gain these objectives would be:

a. Select and intensively train forest officers in initial attack and mop-up.
b. Select and intensively train local cooperators in holding and mop-up.
c. Develop both groups through assignments to respective operations on home forests.
d. List qualifications accordingly on dispatch card and memoranda.
e. Forest fire organization.
   1. Break line function down to show—
      (a) Open—initial attack.
      (b) Controlled—mop-up and patrol.
   2. Designate forest officers and cooperators to fill (a) and (b) above.
f. Large fire assignments.
   1. Plans and Records keep inventories of fire line characteristics.
   2. Plans and Records keep list of all men according to qualifications.
   3. Management assign accordingly.

Thus, management of men, by periods and by sectors, can be directed so that a more efficient job is done in fire suppression. It should not add to the complexity of the existing job because when these essential and smaller elements are broken out then thinking and acting will be done accordingly.

INTENSIVE PRE-PLANNING FOR FIRE SUPPRESSION

Harry D. Grace

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During the development of the fire control portion of the Los Angeles ℞iver Upstream Flood Control program it was recognized that we should ılan, as a fire control objective, to lower the allowable annual burned rea from 0.5 to 0.2 of 1 percent of the total area.

After considering all known factors such as elapsed time, rate of spread, peed of attack, and strength of initial and follow-up forces it was de- ided to intensify the protection already afforded this highly important vatershed. This intensification became one of improving upon the speed f attack plus a pre-planning of fire control lines.

The area covered is that 35-mile stretch of "front country" directly ad- acent to San Fernando Valley and the City of Los Angeles. This is an rea of 277 square miles, or 177,280 acres, most of which is within the ngeles National Forest. The elevation ranges from 1,200 feet in the valley o 5,800 feet at the summit of Mount Wilson.

The cover type is mainly dense impenetrable brush 2 to 15 feet high. 'his brush area is in a zone with one of the highest rates of fire occurrence ı the Angeles Forest. It is also considered the most valuable watershed ı areas in Southern California that have damage appraisal figures rang- ıg up to $1,300 per acre.

With this in mind the purpose of the plan became first, to provide an ıventory of all known possible control lines now in existence and such items s water sources, camp sites, helicopter landing sites, and tractor and trans- ort routes of travel and loading areas; second, to catalog all the infor- ıation on time and materials needed to construct fire control lines and ppurtenances on all usable major fire line sites; third, to provide an esti- ıate based upon actual construction work of the manpower and equip- ıent needed to make a successful attack on any large fire occurring within ıe area.

An attempt has been made to show as much as possible of this data on multilithed 3-color map, thus eliminating long, written data sheets. In ome cases it was necessary to prepare briefly written statements to ac- ompany the map. The detail of this information eliminates the time-con- ıming scouting job necessary to obtain such data before real fire suppres- on planning on a large fire can begin. The use of this detailed plan should ut the fire suppression job at least 4 hours ahead of a normal planning chedule.

HOW THE PLAN WAS MADE

The information needed to prepare this fire plan was obtained in the ollowing manner.

Crews of three men were organized to survey each ridge or canyon bot- om which might be usable as a fire control line. Each party was made up f a man considered an expert in fire control, a tractor-trailbuilder opera- or with fire experience, and a key fire guard. Selection of proposed con- ol lines was based upon a knowledge of the country, use of aerial photos,

and helicopter reconnaissance flights by the local fire control officer. The survey was started in the winter of 1949-50. Three parties were in the field for a period of 4 months collecting information on 255 miles of proposed fire lines.

Each party was instructed to walk every foot of each proposed line and obtain the information called for in the following outline.

INSTRUCTIONS FOR PREPARATION OF FIELD NOTES—FIRE PLAN STUDY

1. *Location of fire lane:* Describe location of ridge to be used for fire lane. Tie location into key road, ranch, or some other landmark and note the direction ridge lays. Key numbers, such as A-1 to A-2, will be assigned when data is placed on base map.
2. *If line to be surveyed is an existing break, describe condition:* Describe condition of present cover, that is, grass, light regrowth, etc. If the break is being maintained show the organization doing the work and method used. If this break can be worked entirely by tractor, and is not presently being maintained by another organization, would there be any distinct advantage in yearly maintenance by the Forest Service?
3. *Total length:* Enter the total length of fire lane as determined by actual measurement on the ground. Also enter the length of those parts of the line that will be worked by hand crews and by tractors.
4. *Maximum grade:* Determine the maximum grade encountered on the fire lane. Also enter the maximum grade on parts of the lane that are to be worked by hand crews and by tractors.
5. *Average grade:* Determine average grade by taking not less than four Abney level shots for each mile. The number of readings taken to determine average grade will depend a great deal on the topography being considered.
6. *Minimum width:* Determine the minimum width required for both hand line and tractor line. The following guide lines are for handling construction: Grass, 2 feet; grass with scattered sage, 2 feet; light to medium chamise, 2½ feet; brush mixture with sage, 4 feet; medium brush and oak, 5 feet; heavy manzanita, chamise, or buckbrush, 5 feet; heavy mixed brush, 6 feet.
7. *Time to complete hand line:* Determine man-hours time to construct required hand line.
8. *Time to complete tractor line:* Determine time needed to complete required tractor line. In many cases the time for two tractors to complete required line should be less than half of time for one tractor because of reduced travel time.
9. *Tractor "X" spots:* Describe in detail the bad spots encountered. Give nature of obstruction. Show time required to build around "X" spots. ("X" spots are obstacles that the tractor must work around.)
10. *Transport travel:* Describe in detail the route of travel, from Arcadia, to tractor loading location. Give names of streets, direction of travel, and mileage where possible.
11. *Tractor loading location:* Describe location, size, turn-around area for transports, etc.
12. *Helicopter site:* Describe location of proposed or existing helicopter landing site. Estimate time in man-days or tractor work time needed to brush, level, and improve each site. (These sites are called helispots or heliports.)
13. *Escape ways:* Describe locations of trails, adjoining breaks, and other avenues of escape and safety zones that might be used by fire crews working this fire line.
14. *Water sources:* List all water sources on or near lane being considered. If a tank or reservoir, show number of gallons, ownership, including names of owner in case of private tanks, whose lock, and size and type of thread on outlet. For hydrants show size and type thread. On yearlong ditches and streams show best drafting location. Describe all locations by landmarks, etc.
15. *Fire camp sites:* Describe location of nearest fire camp site, water facilities, telephone facilities, including ownership of nearest phone line. Also make a radio test with Arcadia.
16. *Private land:* If the lane crosses private land try to get the name and address of landowner to assist in obtaining rights-of-way.
17. *Remarks:* Recommendations for preconstruction of any parts of tractor or hand line for this fire lane should be placed here with supporting reasons for recommendation. Also place here anything of additional importance to fire control that

ou have observed while making the survey of this ridge. Don't be afraid of putting own too much, for every detail may help the fire boss plan his attack at some future ate. BE COMPLETE—BE ACCURATE.

The entire area was broken into seven topographic blocks and each lock assigned a letter of the alphabet. As each line within the respective lock was surveyed its termini were assigned a number prefixed by the lock letter, such as A-1, C-12, etc. Each helispot, water source, "X" spot, scape way, etc., was also designated by identifying numbers. These numers are shown on the map and were later marked on the ground by a etal sign. This identification system enables the plan user to refer quickly om map to written data and it also assures those persons in the field of positive ground identification system.

All estimates made of manpower needs, tractor and hand line construcon time, and necessary widths of control lines were based upon Region 5 re Control Notebook data. In every case estimates were slightly pesnistic.

Field data was recorded on mimeographed field note sheets at the time survey. The proposed fire line and other information was also noted on .S.G.S. topographic maps enlarged to a scale of 10 inches to the mile r field use.

From this field data it was found that most of the lines workable with actors were plagued with "X" spots. These "X" spots consisted of such stacles as rock outcrops, slopes over 65 percent, soil types that do not ford good tractor footing, and man-made hindrances in the form of high nsion power line towers, etc. Wherever such an "X" spot existed it was anned at the time of the survey to build a pioneer road or catway around ese spots (fig. 1). This work ranged in time of construction from 30 inutes to 2 days per "X" spot.

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FURE 1.—Tractor-trailbuilder constructing catway around an "X" spot in steep, brush-covered area.

In order to make the plan more workable, it was necessary that these time-consuming construction jobs be eliminated in advance of a possible fire.

Therefore, all such "X" spots were remapped on a work map and a plan prepared for their elimination. One D-7 tractor-trailbuilder was assigned to this work during the summer of 1950. All "X" spots were eliminated except those requiring less than 30 minutes to construct. En route to these "X" spots along ridge tops the tractor built a 9-foot fire lane (fig. 2). These

F-463455

Figure 2.—Fire lane constructed through heavy brush.

fire lanes are usable fire control lines where the cover is not too tall. In cover more than 2 feet high these lanes provide a ready line for tractors to work from if widening is required. They also provide ways through impenetrable brush fields or into the area for men and tractors, plus tractor-drawn flame throwers and pumpers.

After 10 years these lanes will become overgrown if not maintained. Iowever the information on time of construction and possibilities of tracor use will remain the same indefinitely.

While constructing fire lanes and eliminating "X" spots the tractor also onstructed all helispots in the vicinity. This construction program reuired more than 3 months working time.

After all tractor work was completed a crew of two men posted the dentifying signs. These signs were made of metal and consist of a 12-inch quilateral triangle riveted to a 1½-inch iron pipe set in 24 inches of soil ement (fig. 3). The triangle is painted orange and the post black and range. These colors were found to be the most visible in brush areas. 'hese markers or signs eliminate the possibility of fire crews taking the rong ridge on a proposed line, and they make night identification of idges positive for line construction crews. Air reconnaissance men can lso see the markers from the helicopters.

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FIGURE 3.—Type of marker to identify key points in plan.

The sign crew also constructed helispots on those ridges where tractor ork was impossible. Hand-constructed helispots range in size from 15 et in diameter (brush clearing) to 25 feet. This size helispot will easily ccommodate a Bell or Hiller helicopter. Where a tractor was used to onstruct a helispot the size averages 60 by 60 feet (fig. 4). These larger elispots will accommodate a Sikorsky or Piasecki helicopter, which it is oped will be available in the near future for transporting 8 to 10 men t a time to the fire line. These larger helispots can also be used as safety ones for crews during possible blow-up fire conditions.

F-463457

Figure 4.—Helispot constructed by tractor.

After the field survey was completed it was checked by the local fire control men for possible omissions or errors in judgment.

The field notes were then condensed and as much information as possible was transferred to the field map which was then reduced to a scale of 2½ inches to the mile and multilithed (fig. 5). The multilithed map was then broken down into sheets 8 by 10½ inches and placed with the descriptive data in a loose-leaf binder.

USING THE PLAN

When a fire occurs in the area covered by this plan the following action is taken:

1. Prompt initial attack by men and tankers using direct methods is made while the fire is small.

2. If initial attack forces fail to control the fire while it is small (possible failure of a direct attack is usually determined within 30 minutes after fire is first hit), the fire boss then utilizes the intensive pre-plan data in his copy of the fire plan. On the basis of this data he lays his plan of attack. This information eliminates the need of extensive air and ground scouting *before* over-all plans can be made. In other words, the fire boss has at hand the information needed to make a comprehensive attack plan *now*, not 3 or 4 hours after the fire is known to be a potential large fire, as is the case when ground and air scouting is required.

3. The fire dispatcher, when notified of a fire within the fire plan area, refers to his copy for information on fire needs. If the area is workable by tractor, a tractor transport is dispatched at once to the nearest

tractor unloading spot via a predetermined route of travel. Helicopters are also dispatched to nearest heliports, etc.

Annual revision and maintenance of this plan will be required because of the intensive use of the area. New roads, power lines, and residences will add to or eliminate certain parts of the plan. Each year changes in the plan will be noted by the district ranger and his field men. This information will be turned over to the forest supervisor who will assign personnel to the winter job of keeping the plan up to date.

USE OF PRE-PLANNING ON A SIMULATED FIRE

A fire starting in Schoolhouse Canyon near point A-23 (fig. 5, bottom center) has spread beyond possible control by the initial attack forces. Weather conditions are average bad and the rate of spread upslope in a northwesterly direction is 60 chains per hour. The time is 3:30 p. m. and a wind change from southeast to northeast at 10:00 p. m. is predicted. Rate of spread will decrease to approximately 10 chains per hour after a rise in humidity which was forecast for 6:00 p. m. With this information and the pre-planning data the fire boss is now ready to prepare a comprehensive fire suppression plan for the Schoolhouse Canyon Fire.

He first predicts the rate of spread by 2-hour burning periods. According to his calculations the fire will reach helispot AH-14 on the ridge in about 2½ hours.

Referring to his map (fig. 5) he decides to make a stand on ridges A-17 to A-16; A-16 to A-20; and A-20 to A-26. These ridges were picked as they are the nearest preconstructed fire lanes and he stands a chance to backfire from them.

A fire camp is selected at AFC-6, and the tractor transports are ordered into AT-6 and AT-4, which is not shown on map but is 1 mile west of point AW-5.

A helicopter, which is an initial attack tool on this forest, arrived along with the first crews some 30 minutes before this plan was made.

Using the helicopter to transport some of the initial attack men to helispot AH-16, which is the highest point on the ridge, the fire boss prepares to backfire. Other helicopters are ordered to transport more fire fighters to the fire line.

Initial-attack, 4-wheel drive, 300-gallon tank trucks are dispatched up road to points A-20 and A-25 to aid in holding line to be backfired.

Referring to the fire line data the fire boss determines the following:

A-16 to A-17: Orders 2 tractors to widen fire lane to 40 feet and 40 men to build hand line and hold backfire. (See sample Fire Line Data.)

A-16 to A-20: Orders 2 tractors to widen old firebreak and 60 men to hold backfire.

A-20 to A-26: Orders 2 tractors to complete widening job from A-20 to A-25. Orders 60 men to handle backfire along this line. (A-25 to A-26 is firebreak 40 feet wide and no further work is needed.) Men on upper part of fire line are to be fed and supplied by fire camp located at AFC-5.

Tractors to be provided with fuel and fresh operators by helicopters using those helispots along the line. Some hand crew men are spotted along the line by helicopter to save long walking distances and time.

Fearing a possible blow-up during the next day if northeast winds should continue, the fire boss redistributed his tractors after all lines are widened. Two tractors are sent to A-28 to widen line from that point to A-29 as a safety line.

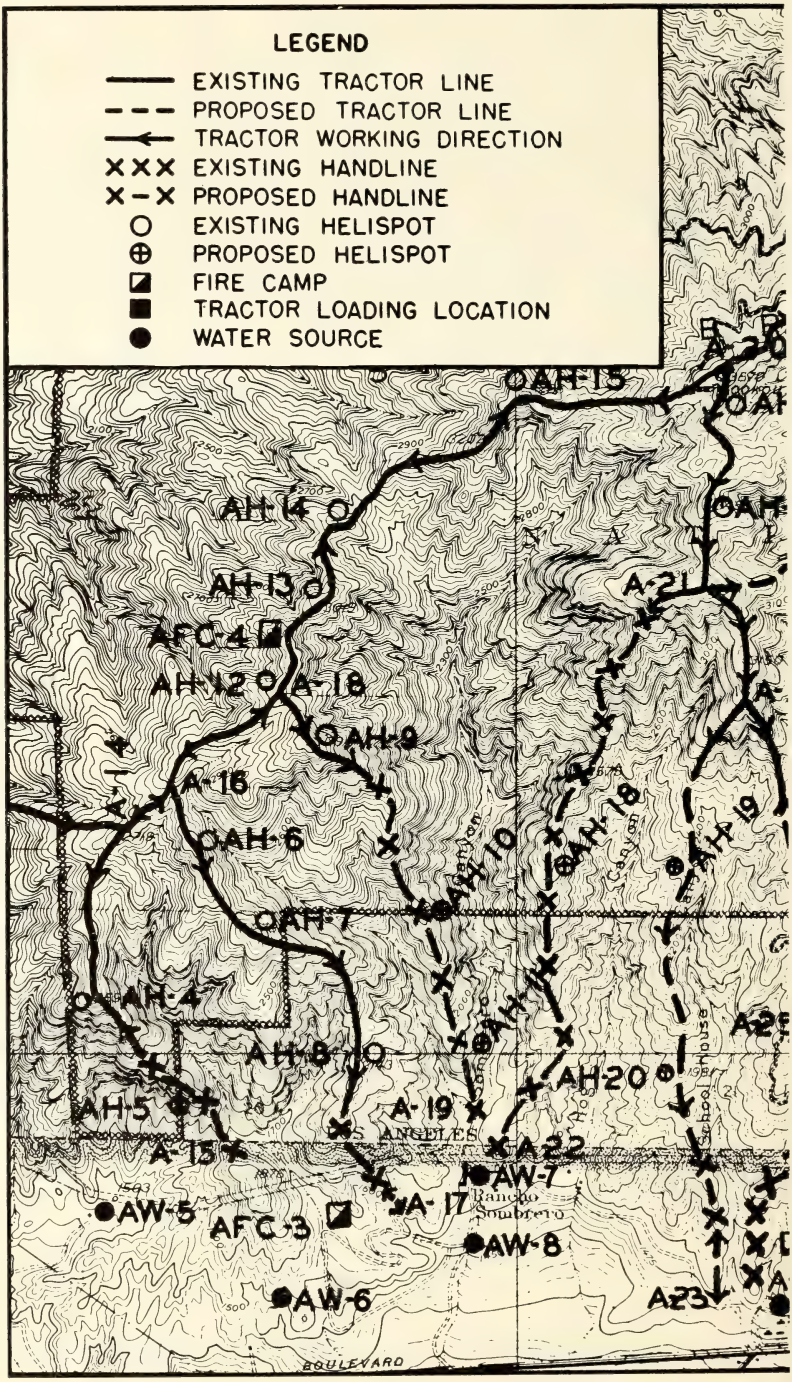

FIGURE 5.—Part of area covered by intensive plan; scale: 2¼ inches equal 1 mil

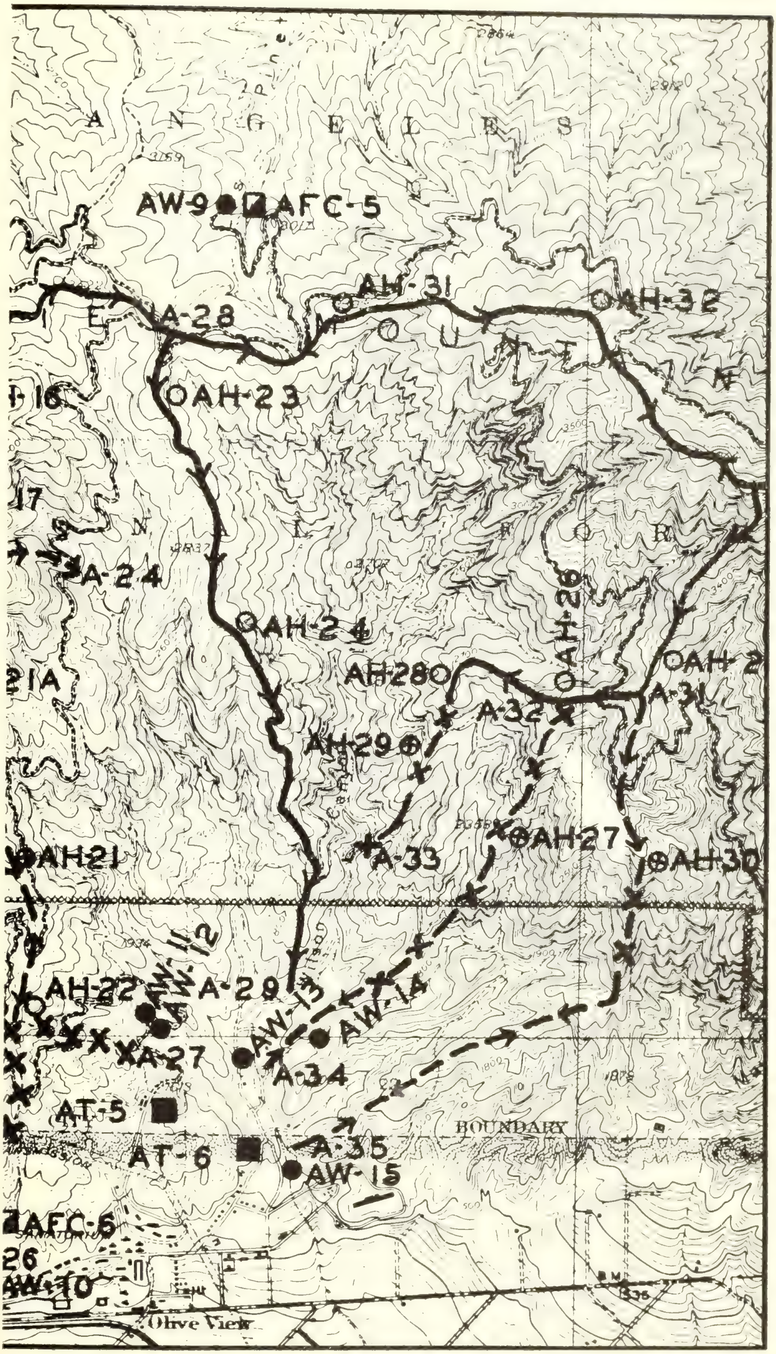

Figure 5 continued.

SAMPLE DATA

The following are examples of the line, fire camp, and transportatio data that accompany the maps.

FIRE LINE DATA

East ½ of Block A

A-14 to A-15 *HAND LINE:* 33 ch., 96%, med. brush, steep knife ridge, 15-ft line required, 160 man-hrs. *TRACTOR LINE:* 33 ch., 37%, heavy brush 40-ft. line required, 1 cat 6 hrs., 2 cats 3 hrs. *TRAVEL:* Tractor from AT- via Grapevine T.T., A-13, A-12 to A-14, 1¼ hrs. *HELISPOTS:* AH-4, ¼ hr tractor, 4 man-hrs.; AH-5, 2 man-hrs. *WATER:* AW-4, 3,000 gal. Circle M Ranch draft; AW-5, 5,000 gal. Symonds Reservoir draft. *FIRE CAMP:* AFC-3

FIRE CAMP DATA

East ½ of Block A—AFC-2 to AFC-6

AFC-6 Located at Olive View Park. From Foothill Blvd. at east end of Oliv View Sanatorium, turn north on Colbalt Ave. to Olive View Ave. Turn righ (east) on Olive View Ave. to Sycamore Ave. Turn left (north) on Sycamor Ave. to AFC-6 at Olive View Park. Water from Olive View water systen available at campsite. Telephone available at Olive View on Calif. Water & Tel. Line. Radio communications with A-50 at Newhall R. S.

TRACTOR LOADING AND ROUTE OF TRAVEL

Block A

AT-6 Transport tractor via Foothill Blvd. to east end of Olive Sanatorium. Tur right (north) on Colbalt Ave. to Olive View Ave. Turn right (east) on Oliv View Ave. to Sycamore Ave. Turn left (north) on Sycamore Ave. to AT- at Olive View Park near gate on the Armstrong Ranch. 1½ hours transpor travel from Arcadia.

CONCLUSION

This type of intensive fire suppression plan is not a luxury for an are in which flash fuels and high values make fast, well-planned action imperative. Minuteness of detail eliminates the time-consuming scout worl which is needed on a going fire to prepare a successful fire suppressio plan of action. Because this data was collected by experienced fire mer not under the pressure of fire conditions it also eliminates the possibility of unusable information reaching the fire boss.

'olume 12 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

'NITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1951

CONTENTS

THE POSSIBLE RELATION OF AIR TURBULENCE TO ERRATIC FIRE BEHAVIOR IN THE SOUTHEAST

George M. Byram and Ralph M. Nelson

Division of Fire Research, Southeastern Forest Experiment Station

[“Blowups” and other forms of unaccountable fire behavior, that characterize ny of our more disastrous fires every year, were a special topic that was given ch emphasis at the fire meeting held in Ogden in January 1950. New research this problem was urged and all research men were urged too to make available ry bit of new information that might be useful to the fire strategist even though s might mean some reporting ahead of final evaluation. I am very happy to sent the following report by two members of the research group as new infortion that I personally believe is highly significant though further confirmation, luation, and means of prediction are needed and will require much further estigation. If the degree of local stability in the atmosphere proves to be a key tor in the unexpected and often dangerous behavior of many of our large fires, d it can be identified in advance, one more of the unknowns will be eliminated d skill in control of large fires can be greatly advanced. This preliminary report uld be a challenge to all experienced fire fighters and research men alike. Have been ignoring one of the controlling factors in big fire behavior?—A. A. Brown.]

Fire control men have long suspected that there are unidentified facs that contribute to the strange behavior and spread of some fires. H. Gisborne, G. L. Hayes, and A. A. Brown, among others, have believed t atmospheric instability might in part explain some of the western w-up fires. Brown (1) and Crosby (2) speaking more generally have ted that when sufficient heat is generated by a fire in an unstable atsphere, erratic fire behavior can be expected. In a report from Australia), turbulence is stated to be an important factor in the degree of severity bush fires and that it is of value in compiling forecasts of fire weather. ere is now reason to believe that turbulence may also be associated with tain severe fires in the South. Some evidence on this point was obtained m fires that burned in an unusual manner in the Coastal Plain of South rolina during a few days of the 1950 spring fire season.

Southeastern States experienced an unusually severe season during that riod. A prolonged drought, interrupted only by occasional rains, began November and persisted in some areas until May. This brought about normally low fuel moistures which, combined with high winds, resulted a large number of fires and a large acreage burned. Apparently there re two rather definite types of severe fires. The first, driven by high nds, was characterized by high rates of spread, especially while crown. From the standpoint of the safety of suppression crews and their equipnt, this type of fire has not been considered dangerous for experienced fighters in the Southeast. The second type differed from the first in t its peculiar whirling nature and unpredictable behavior made even lank attack dangerous. It is with the second type that this report is cerned.

THE BUCKLE ISLAND AND FAREWELL FIRES[1]

Following is a description of two whirling fires that occurred on th Francis Marion National Forest in South Carolina. So far as can be asce tained, they had characteristics of behavior common to fires that burne elsewhere in the Coastal Plain of that State during the five or six mo severe days of the spring season.

The Buckle Island No. 144 fire burned on March 26 in a densely stocke stand of loblolly pine 10 to 35 feet in height. The day was sunny with litt wind during the morning hours. The relative humidity was medium (abo 35 percent) and the records of the Weather Bureau airport station, lo cated approximately 40 miles from the burned area, indicated a lay of highly unstable air about 400 or 500 feet deep at 10 a. m. The lay probably had become even more unstable and somewhat deeper at th time the fire started in the early afternoon. However, the increased turbu lence may have been partly offset by an increase in wind velocity whic took place at about noon. Apparently no large whirl developed until th fire reached a size of 40 or more acres. One then enclosed the head an created trouble for the plow crews. Because the early spread of the fi was nearly at right angles to the road, no short cut to the head was po sible. Therefore, a flanking attack on both sides was made. As the plo crews progressed, the fire on the left flank had a tendency to cross in fro of the crew, and on the right flank, behind the crew. One large counte clockwise whirl or two such whirls, one on each flank, could account fo this strange behavior. It was later found that there was at least one sma whirl on the right flank, although from the plane observer Mitchum sa only one large whirl.

The Buckle Island fire differed somewhat from other whirling fires that it apparently maintained a fairly constant direction of spread. Th wind velocity was also greater and steadier than on other fires. Even s the spread was erratic. At times the fire would quiet down and then su denly burn with fierce intensity. These bursts may have been caused b the almost simultaneous ignition of several acres by the whirl. In one i stance, the plow crew observed flames directly overhead while the ma fire was still some distance away.

The most severe fire on the Francis Marion National Forest during th spring season from the standpoint of erratic behavior and its whirling n ture was Farewell No. 172. It burned on April 11 with a light but variab southwest wind in a stand of loblolly reproduction 10 to 35 feet in heig which contained a scattering of mature trees. Weather Bureau recor indicated a high degree of atmospheric instability also on that day. The were three large whirls in this fire and at least two small ones. The pat of the larger whirls were approximately parallel and were separated less severely burned strips 75 to 100 feet in width. Needles on tree crow in the strips were not consumed, and in a number of places the tops crowns of trees 25 feet high remained alive. However, in the paths of t whirls the crown foliage was generally completely consumed, on some tre to a height of 80 feet. Needles are not completely consumed unless th are well within the flames, so it is estimated that the flames may ha ranged from 50 to 150 feet in height.

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[1] Acknowledgment is made to John T. Koen, formerly ranger on the Fran Marion National Forest, to John T. Hills, Jr., and Aiken Mitchum of the Natio Forest staff for eyewitness accounts of the fires reported upon.

After becoming established, the whirls moved rapidly ahead of the main re with sufficient updraft to carry burning embers aloft. These embers e reported to have started fires a considerable distance ahead of the main re. Airplane observer Mitchum believes that two of the three whirls urned at the same time. He also observed that flames came out of the nter of the tops of the cone-shaped whirls. The flames did not spring rectly upward but had the same rotary motion, spiralling upward, as e smoke in the outer parts of the whirls.

SOME CHARACTERISTICS OF ERRATIC FIRES

Evidence from the Buckle Island and Farewell fires, and from others at burned in South Carolina during the spring season of 1950, indi-tes that erratic fires in the Southeast may have some common charac-ristics. Also, there appear to be certain conditions of weather, fuel, and pe—not fully identified—which are conducive to such fires. Although me of the following conclusions regarding fire behavior and possible uses are speculative, they appear reasonable in view of what is known certain physical laws. Confirmation or disproval will require further servation and analysis.

1. Fires with erratic behavior are most likely to occur on sunny days hen there is strong surface heating. There may be little or no wind dur-g the early part of the day, and even while the fire is burning, usually the afternoon, the general wind is light or moderate. The most favor-le wind for this type may be somewhere between 8 and 16 miles r hour as measured 20 feet above tree tops.

2. Erratic fires have a tendency to develop one or more violent whirls ter reaching a certain critical size. The size is probably not the same r all fires and may be somewhere between 20 and 75 acres. This, how-er, is merely conjecture.

3. From the air, the diameter of larger whirls appeared to remain ap-oximately constant and to cover an area of about 10 acres. An increase size after they had formed was not observed. Possibly they appear sud-nly and may be nearly full-size when born. After becoming established, e whirls apparently can move rapidly away from the main fire and take e direction of the light wind prevailing at the time. They can consume ips of reproduction 500 to 800 feet wide. The velocity with which these hirls travel is one of their most dangerous characteristics because their eed may be equal to, or nearly equal to, the velocity of prevailing winds.

4. Field men state that most of the worst fires occur on days with a uthwest wind. This indicates a characteristic pressure system which may o account for some of the turbulence. Observers in airplanes have no-ed that the air was always bumpy on days when whirling fires occurred. so, when the flying became smooth in the late afternoon whirls did not cur.

5. It cannot be assumed that whirls will always rotate counterclockwise e large-scale vortex storms such as hurricanes in the northern hemisphere. he counterclockwise rotation of the hurricane is caused by the rotation the earth. This should have but little effect on small-scale whirls like st devils or whirling fires. For this reason the chances are probably about ual that the whirls will be in either direction.

6. The depth of the turbulent layer may be a dominating factor in de-

termining the maximum size of the whirls, although other variables such as quantity of fuel should also have some effect.

7. In flat country it is doubtful that large whirls could develop if the air were absolutely calm, regardless of turbulence. Some wind movement would be necessary to move them over fresh fuel. A high wind, on the other hand, would reduce turbulence and might also tend to break up the whirls. This does not mean that fires burning in a high wind will be less intense than fires burning in a light wind. A large majority of severe fires probably burn on days of high wind velocity, and rate of spread will increase with increasing wind velocity.

8. The effects of turbulence in areas of rough or rolling topography would be considerably more complex than in flat country. Turbulence near the ground surface would probably never be as great as in flat country but this would possibly be more than offset by complex topographic effects. For example, large whirls could travel upslope rapidly even in an absolute calm.

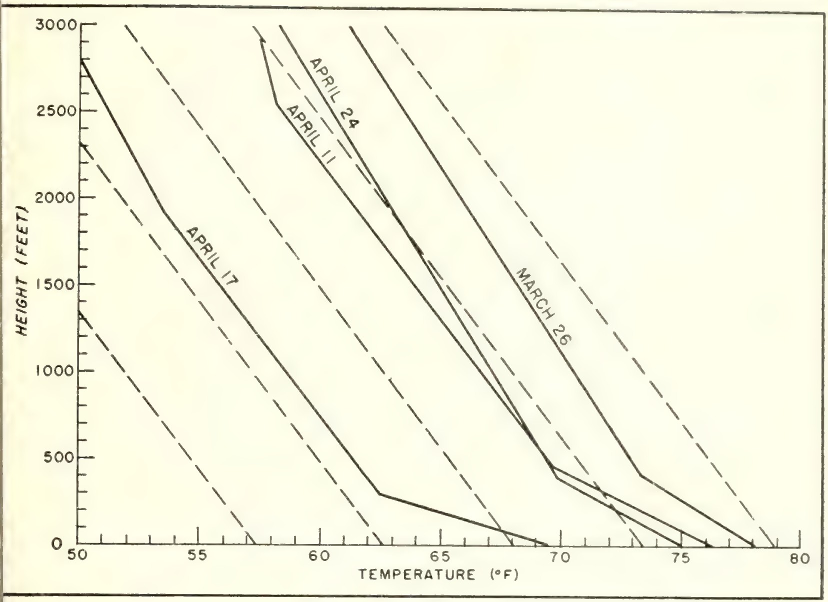
9. An important factor in the occurrence of the whirling type of fire may be the fairly recent change in stand type in much of the Southeast. During the past 15 years extensive stands of dense pine reproduction have become established on areas formerly kept clear of pine by repeated fires. This may be one reason why there have not been more of these fires in former years. On the other hand, they may have occurred more often than is supposed. It is difficult for ground crews to recognize large whirls because of smoke and a limited field of view. They can be seen best from the air.

10. Perhaps too much emphasis should not be placed on just the whirling characteristics of fires burning in turbulent air. Turbulence could have a pronounced effect on the draft of a fire long before it reaches the whirling stage. It was noticed that on days when there was high turbulence even small fires burned with strong drafts. The opposite of this has long been familiar to fire fighters. Fires usually undergo a pronounced change in behavior in late afternoon and evening when the atmosphere becomes more stable. This change has often been attributed to the increase in relative humidity which accompanies the drop in temperature of the lower air layers. It is possible that an increase in air stability may have as great or greater influence on behavior than a combination of increased fuel moisture and decreased fuel temperature.

THE INFLUENCE OF ATMOSPHERIC INSTABILITY ON FIRES

Unusual fire behavior, not previously experienced, was reported for the Francis Marion National Forest on March 26, April 11, 17, and 24 by suppression crews. This behavior, characterized by one or more whirlwinds and by sudden fierce upward bursts of flames, could not be accounted for by any exceptional conditions of fuel or wind. This led the writer to suspect that some unusual atmospheric conditions existed at the time of the fires. Accordingly, 10 a. m. lapse-rate records for the 4 days mentioned were obtained from the Weather Bureau station at the Charleston airport. These are graphed in figure 1.

The straight dashed lines in the graph represent the dry adiabatic lapse rates, that is, a decrease in air temperature of 0.53° F. per hundred feet in height. At this rate of decrease the atmosphere is neutrally stable. The greater the drop in temperature with height, the greater the air instability. Conversely, the less the drop in temperature with height, the



GURE 1.—Ten a.m. lapse rates for March 26, April 11, 17, and 24, 1950. The straight dashed lines represent the dry adiabatic lapse rates, i.e., a decrease of 0.53° F. per hundred feet in height.

ss the instability. For example, on calm, clear nights, the air tempera-re often does not decrease with height but even increases. The atmosphere then highly stable and the upward movement of smoke and heated gas ay stop completely after reaching a certain height.

From the graph it will be seen that the unbroken lines, representing pse rates for the 4 days, inclined sharply to the left of the dashed lines r a distance equivalent to a height of 300 to 500 feet. This means that yers of highly unstable air existed at these depths. These conditions of r turbulence, coinciding with certain fuel and stand conditions, and size fire or rate of energy output, are believed to explain the strange fire havior on the days mentioned.

There is usually some turbulence on clear sunny days, but the average lue of the turbulence factor [2] is not known for the Coastal Plain in rly spring. Its value may be somewhere between 20 and 50. In contrast, e turbulence factors for March 26, April 11, 17, and 24, were respec-vely 110, 160, 390, and 135. It is possible that there were other days iring the spring season that had equally high turbulence factors, but hirls or erratic fire behavior were not observed. If highly turbulent days d occur, it may be that fires were controlled while small or before they

---

[2] A turbulence factor T will be defined by the equation

$$T = 100\ (\frac{L_e}{L_a} - 1),$$

here L_e is the existing lapse rate and L_a is the dry adiabatic lapse rate. When $= L_a$, the air is neutrally stable and $T = 0$. Whenever T is greater than 0 there always some turbulence.

reached the breaking point, or that they did not burn under the fuel and stand conditions most favorable to turbulence. Further analysis should clarify this point.

As has been pointed out previously, very severe fires can occur on days when the atmosphere is relatively stable. On March 27 the turbulence factor was only 16, but this was a severe fire day. As a result of high wind velocity—30 to 40 miles per hour with gusts reaching almost 60 miles per hour at the Charleston airport—there were intense, fast-spreading fires which did great damage. There was nothing erratic or baffling in their behavior, however, that could not be explained in terms of wind and fuel conditions.

When a fire burns in a stable atmosphere, the hot gases must not only expend energy as they lift their masses through the stable air, but they also expend part of their energy in dragging a part of the surrounding air upwards. The stable air acts like a ceiling so that on a calm clear evening the smoke rising above a fire will reach a certain height and then level off. The conditions are entirely different when a fire burns in an unstable atmosphere. The gases do not expend energy as they rise but in their ascent they may even acquire energy from the atmosphere. Their path upward creates a chimney into which the surrounding unstable air is drawn. The potential energy of the unstable air is then converted into kinetic energy as it enters the chimney created by the fire. When the total rate of energy release (rate of energy output of fire plus rate of energy change in the unstable atmosphere) is great enough, then whirls should develop.

ATMOSPHERIC INSTABILITY AND DUST DEVILS

There appears to be similarity in some of the conditions which favor the development of whirls on some erratic fires and dust devils. These are strong surface heating on clear days, and winds of not more than moderate velocity. Ives (4) gives the following account of the conditions favorable for their formation.

> "In geographically favorable areas dust devils occur most frequently in clear weather, when the surface has been heated for some hours, and there is little surface wind. Under these conditions the surface air is very hot with respect to that a few hundred feet aloft . . . Typically favorable conditions, measured during a 'Great-Basin-High regime' are: surface temperature, 160° F.; one foot above surface, 142° F.; five feet above surface, 116° F.; 500 feet above surface, 100° F.; 2,000 feet above surface, 92° F. . . . "

Such a pronounced drop in temperature means, of course, an extremely unstable atmosphere near the ground. Ives further states that the upward velocity of the air in a dust devil may exceed 35 miles per hour and that measured horizontal winds within the whirl can accelerate from near zero to speeds of from 50 to more than 90 miles per hour and then return to their former velocity within 30 to 100 seconds. Velocities within the whirls on the southeastern fires are not known, but they are strong enough to carry burning embers for considerable distances ahead of the main fire.

Williams (5) gives the range in size for dust devils as varying from 20 to 200 feet in diameter and from 10 to 4,000 feet in height. It thus appears

hat the largest dust devils occupy an area only about one-tenth as great s the area of the larger whirls on the South Carolina fires. The main ifference between dust devils and whirls on fires is that the former nust obtain all of their energy from the potential energy of the atmosphere, vhereas the latter obtain their energy from burning fuel as well as the tmosphere. In the same article Williams states:

> These occurrence times were from 1 to 5 hours before the times of maximum temperatures. The reason for this fact is that the wind speeds normally increase as the times of maximum temperatures are approached and certain critical speeds are reached beyond which the dust whirls cannot exist. These critical speeds have not yet been determined, but vary with lapse rate, topography, and probably other factors.

Brown (1) states that dust devils are an ominous sign to fire fighters. Vhirls of a similar nature on fires may account for many blow-ups.

LAPSE RATE IS RELATED TO FIRE CONTROL

If the conclusions reached regarding the effect of air turbulence on re behavior are substantiated by additional work, a new aspect of re control in the Southeast will have been recognized. Although erratic res in this section may not be common, their potential danger to supression crews and damage to timber stands, particularly in the younger ge classes, will justify the taking of extra precautions during especially azardous periods. Radiosonde observations, where available, will be elpful but the extent of the adjacent area to which these apply will ave to be determined. Forecasts of high impending turbulence a day r two in advance would be most useful, although a forewarning of ven a few hours might mean considerable for the safety of men and quipment. Suppression crews during such periods could be alerted to nake the fastest possible attack so as to restrict any fire to the smallest ossible acreage and before it reached the breaking point. In short, they ould be warned to expect crowning and the sudden formation of large vhirls, unusual backfire behavior, exceptional rates of spread considering xisting wind velocities, gustiness and quick changes in wind direction, nd the likelihood of danger even in making flank attacks.

It should be emphasized again that the changing fuel and stand types ccurring in the Southeast may be a necessary condition for the large vhirling fires which burned in South Carolina last year. These fires urned in dense stands of reproduction (predominantly loblolly pine) n which the compact crowns constituted the main source of fuel. In turn, he availability of this green fuel for combustion was increased by an nstable atmosphere plus a high rate of energy release in the ground fuels.

[Since this report was written, data have been obtained from the Veather Bureau which give the upper air temperatures at the Charleston irport for all days in the period from March 20 to April 30. Although complete analysis has not yet been made, these data indicate that there vere only eight days in this period with a highly unstable atmosphere. our of these days were March 26, April 11, 17, and 24 when severe vhirling fires occurred. On the other four unstable days, no whirling res were reported. April 27, the atmosphere was very unstable at 10:00 . m., but 0.41 inches of rain fell later in the day before 5:00 p. m. imilar turbulent conditions existed on April 6 and 27, but 0.33 inch

of rain fell on April 5 and 0.60 inch on April 27 and 28. The chances were very slight for fires starting and building up to a high rate of energy output on these days, especially in dense stands of young loblolly pine. On April 19 there was a highly unstable layer of surface air but it was only 150 feet deep. In addition, the next layer above was deep and stable. It is doubtful if large whirling fires could develop on such a day. However, the shallow layer should have had a marked effect on the behavior of small fires. This additional evidence appears to corroborate some of the ideas advanced in the report.]

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Smoke-Eaters at Work

A lot of people talk about forest fires. Down Joplin way, some people are doing something about it, under the supervision of that city's Natural Resources committee of the Chamber of Commerce, and under the leadership of Don Hunsaker, assistant manager of the Chamber.

The group of fire fighters, known as the Smoke-Eaters was organized in the spring of 1950, for volunteer forest protection and fought several fires last year. Last February, it was reorganized on a larger basis to help handle this year's burns. It now includes 30 men, divided into "telephone groups" of five or six under a group captain who calls up his team on instructions from Hunsaker. In addition, there are 50 to 100 emergency volunteers, while, for serious fires, arrangements have been made to mobilize the Boy Scout and Explorer Scout troops of Joplin.

All fire fighting is done under the jurisdiction and at the call of the Conservation Commission's forestry personnel. The Smoke-Eaters fight not only forest fires but field blazes also, and their creed is based on prevention of fires where possible.

Among the Smoke-Eaters are doctors, lawyers, bankers, newspapermen, Boy Scout heads, sporting goods retailers, salesmen, a retail store manager, a veterinarian, printer, publisher, florist, manufacturer, and many other professions. All of them are bound together by their interest in the natural resources of southwest Missouri; all have had some training under Martin Grau, farm forester from Monett, and District Forester Joe Range of Pineville.—From MISSOURI CONSERVATIONIST *April* 1951.

SAFETY DEVICE FOR LOOKOUT TOWER LADDERS

SETH JACKSON

Administrative Officer, U. S. Forest Service, Washington, D. C.

Tower ladder accidents are not frequent, but when one does happen it is usually serious, if not fatal. A new development in the safety field offers protection from this danger. It is a device which can be fastened to any tower ladder to protect the climber from a fall.

It consists of a 1-inch steel pipe bolted to the center of the rungs running the full length of the ladder. This can be fastened to a 100-foot tower by three men in about 2 hours. A bronze sleeve travels up and down the pipe when it is attached to the safety belt of a climber. The pipe is notched at about 6-inch intervals (fig. 1).

FIGURE 1.—Safety device in normal climbing position.

Operation of the device is very simple: The climber snaps his safety belt to the sleeve. He climbs in a normal position which automatically holds the lock open. In case he starts to fall, the device automatically locks in the next 6-inch notch, positively preventing the fall. The pipe does not interfere with climbing the ladder in the usual manner, if a person does not have a safety belt with him.

In the Northern States when there is ice danger, a car exhaust or propane tank and burner can be attached to the bottom of the pipe for de-icing, since the pipe is air-tight to the top. After attaching his belt to the sleeve, a towerman can then climb the icy rungs with perfect safety.

The installation costs about $225 for a 100-foot tower. It is manufactured in Burbank, Calif.

RAILROAD TANK CAR

A. B. Everts

Division of Fire Control, Region 6, U. S. Forest Service

Railroad tank cars, which have wide and varied use throughout the United States, make effective fire suppression equipment. Many of the tank cars on logging operations use steam-operated piston-type pumps, and it is necessary that a locomotive be on hand to furnish the steam. The White River Division of the Weyerhaeuser Timber Company at Enumclaw, Wash., has three 8,000-gallon tank cars, each equipped with an independent pump and motor (fig. 1).

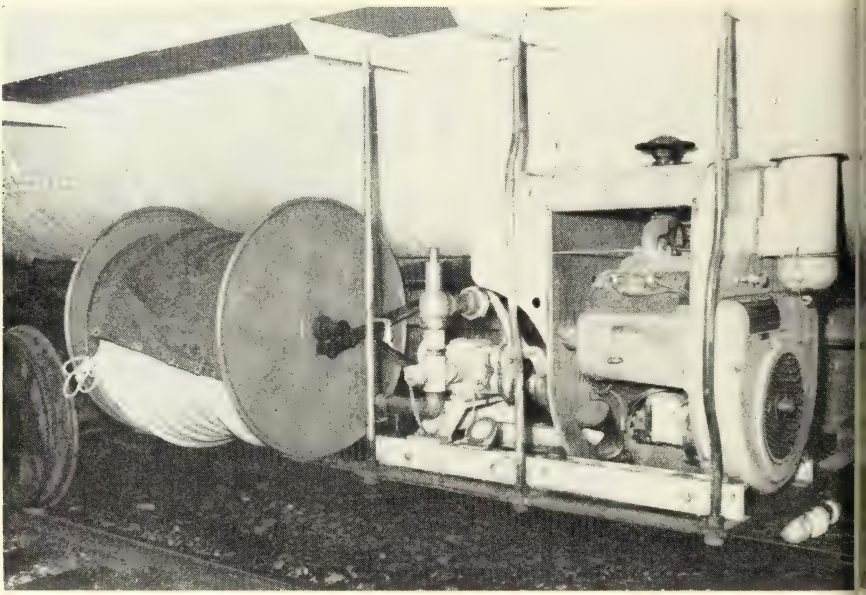


Figure 1.—Details of White River 8,000-gallon railroad tank car. Hose is carried on a dummy reel.

The advantage of the independent pump and motor is that a tank car can be spotted near a fire and used while the locomotive is doing other work. In addition, the pump is capable of delivering up to 89 gallons per minute at 100 pounds pressure. This means that three or four 1½-inch hose lines can be used, a much greater capacity than ordinarily can be obtained from piston-type steam pumps.

The 8,000-gallon tank cars are equipped with gear type pumps driven by 4-cylinder, V-type, air-cooled engines. The bypass is set at 150 pounds.

Pipe-line strainers are used to keep foreign matter out of the hose line, and 1,500 feet of 1½-inch CJRL hose are mounted on two or three dead reels. Also carried are three 1½-inch combination fog, straight-stream, and shut-off nozzles and two 1½-inch siamese valves. Other equipment to round out the tank car as a fire-fighting unit includes six shovels, six adz hoes, three axes, two saws, one backpack pump, and one pulaski. Extra gasoline, oil, pipe wrenches, and tools complete the unit (fig. 2).

[Fire Warden Monte Rodie, to whom the writer is indebted for the information for this article, insists that all fire equipment (the railroad tank cars are only a small part of the total in use) be kept in first-class condition and that woods crews know how to operate the various kinds.]

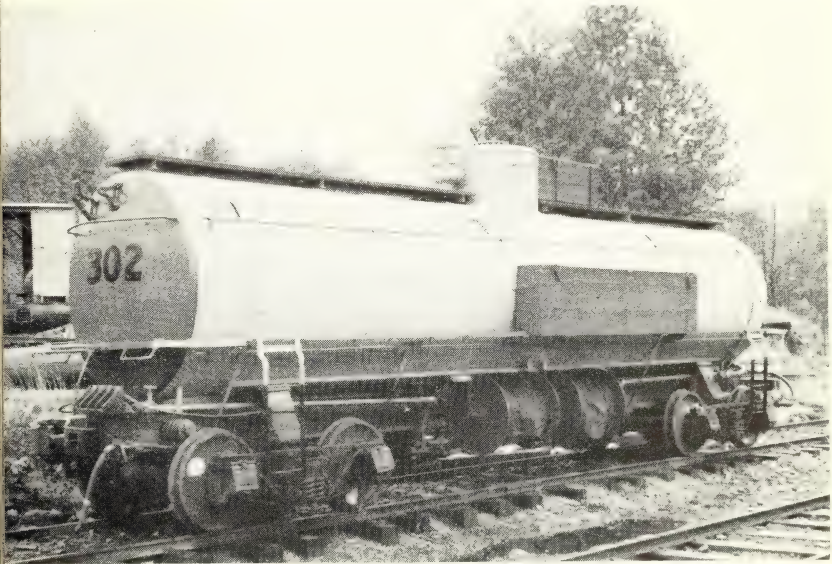


FIGURE 2.—White River tank car with dead reels and tool boxes. Pump and engine are on other side.

HOSE TESTING AND DRYING RACK

Roy O. Walker
Division of Fire Control, Region 6, U. S. Forest Service

The regional fire cache in Portland, Oreg., carries a supply of fire-fighting equipment to back up project fires on the national forests in Oregon and Washington. Our plan calls for a minimum of 59,000 feet of 1½-inch hose. There have been times when all this hose has been out on fires. The job of washing, testing, drying, rolling, and storing this hose is a big one. The layout for doing this job is shown in figure 1.

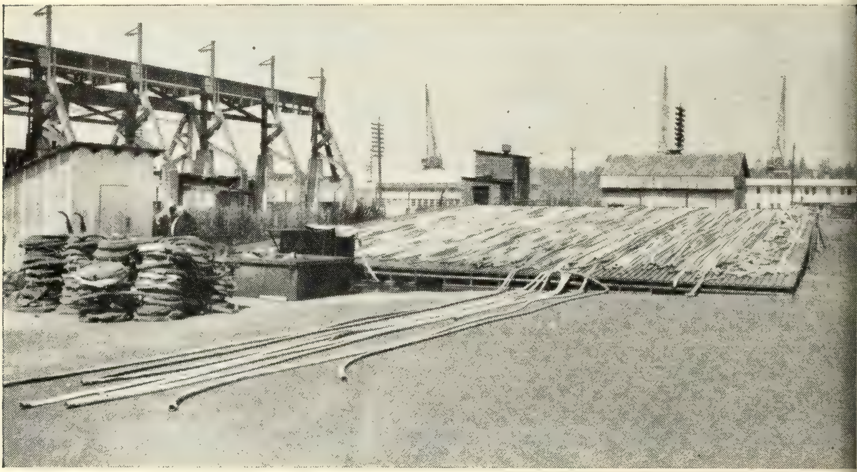
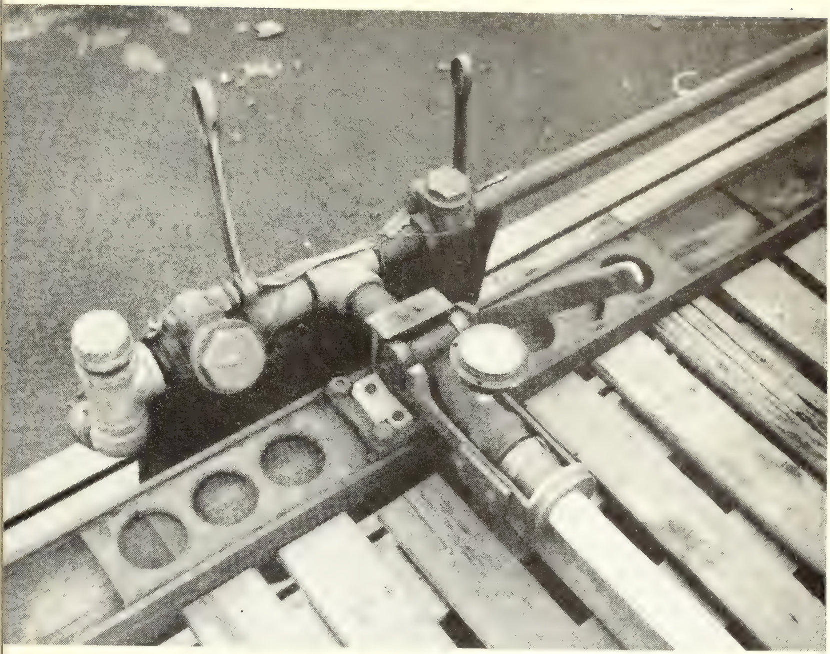


Figure 1.—Over-all layout and arrangement of hose washing, testing, and drying rack.

The steps in the process are as follows:

1. Dirty hose, loosely rolled, comes in from the fires.
2. The hose is then soaked in one of two 6- by 6-foot galvanized tanks, 27 inches deep, to loosen the dirt and grime.
3. After soaking, tie strings are removed and the female end is threaded through a "doughnut" hose washer and pulled out on the rack. The washer operates at 150 pounds' pressure, and hose is washed by the simple process of pulling it through the doughnut.[1]
4. The female end of the hose is then attached to the tester head shown in figure 2. It is not necessary to screw the coupling on to the water discharge; once the "gripper" arm is placed over the coupling and the cam lever pushed forward, the hose is held in place. The hose is tested at 225 pounds' pressure, read direct from the pressure gage.

[1] For details of the doughnut hose washer, see January 1949 issue of FIRE CONTROL NOTES, p. 28.



IGURE 2.—Tester head. Cam lever in foreground operates "gripper" which holds female end of hose tight against discharge port. Coupling is not screwed on. Lever on left operates intake valve. Lever on right operates the release.

5. At the lower end of the rack, one man screws on 1½-inch caps, sually having a half dozen with which to work. These caps have 1/16-inch oles drilled in them to allow the air to escape.

6. The entire tester head moves on a track. Thus it is possible to start t one edge of the rack and work across as the male ends of the hose are apped at the bottom of the rack.

With this arrangement, two men can wash and test 15,000 feet of ose in 8 hours.

The hose rack is 58 feet long and 50 feet wide.

Pressure for testing is provided by a 2½-inch, electric-driven pump ooked up to the city water supply. Water from the pump goes direct a high pressure booster tank equipped with a relief valve and by-ass. One-and-one-half-inch hose runs from this booster tank to the ster head.

More detailed information is available for interested persons from egional Forester, Post Office Building, Portland, Oreg.

EJECTOR SUCTION BOOSTER

ARCADIA EQUIPMENT DEVELOPMENT CENTER
Region 5, U. S. Forest Service

"Water, water everywhere, but not a drop to drink." By changing the last word to "draft," we have a condition which is common to fire fighting in forest areas where numerous streams and lakes exist, but whose resources cannot be utilized without undue delay, because fire trucks cannot approach sufficiently close to draft water.

By using a very simple, inexpensive gadget, which we choose to call an eductor, but known also as an ejector or jet pump, matched to the pumper on the fire truck, water can be lifted 100 feet vertically; reservoirs 200 or 300 feet away can be tapped; or tanks can be refilled at twice the output of the pumper. In some instances, dirty sand-laden water from an existing sump could be utilized for pumping onto a fire at triple the pump's output, with no damage to equipment.

Eductors for operation with portable pumpers can be purchased at \$7 to \$25. They weigh 1¼ to 14 pounds, and have no moving parts to wear out or get out of order.

Eductors have been used in industry for years for elevating or mixing liquids by use of water under pressure as motive power. In 1949, the Arcadia Equipment Development Center secured numerous makes and sizes of eductors to determine their adaptability to forest fire fighting activity, and select the types best suited to pumpers commonly used (fig. 1).

Since eductors are not in common use on fire equipment, it might be well to explain the principle on which they operate. Water is pumped

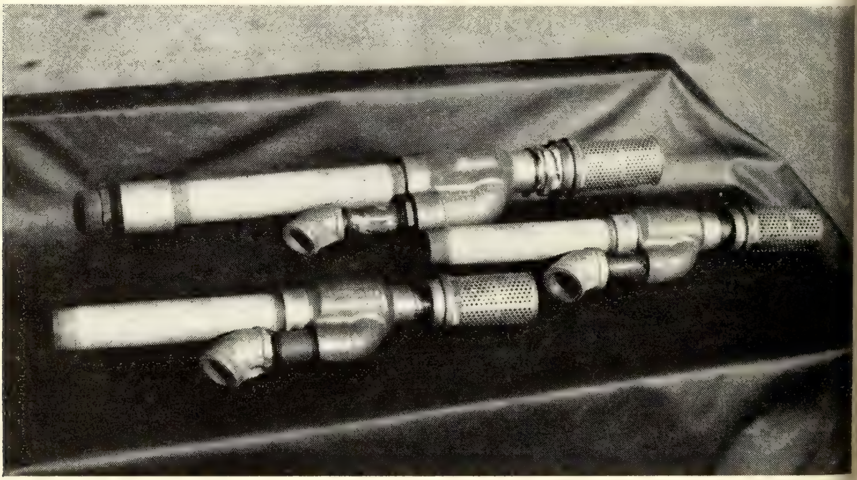


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FIGURE 1.—Three eductors used on tests.

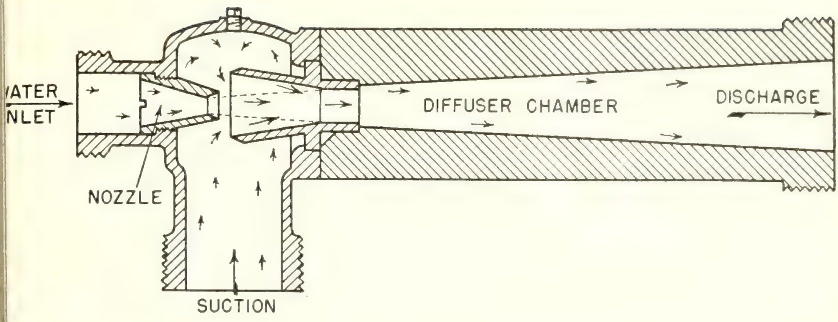

FIGURE 2.—Cross section of eductor.

ırough a built-in nozzle at high pressure into a diffuser chamber where xtra water is picked up or entrained by the high velocity stream (fig. 2) ıst as a person's hat is dislodged by the passing of a fast-moving vehicle, ue to so-called suction.

The eductor should be submerged in the pickup water for most efficient peration. However, a suction pipe or hose from the eductor to the ater source will provide pick up of water at a reduced rate, depending n the suction lift. For trouble-free operation, the former operation ıethod is recommended because no suction leaks are present to cause ılure, all lines and connections being under pressure.

Recent checks of field operation of pumpers show that difficulty with ıction is one of the most common field failures. In spite of manufac-ırers' claims, it is obvious that soon after use, pump suction ability rops off. As wear increases, a 10-foot lift is not uncommon as the aximum ability of a dry positive displacement pump. Add to this, ılures due to leaky suction hose, loose connections, poor or wrong size ıskets, and losses due to elevation, and the drafting operation can resent an infinite source of trouble.

In contrast to this, an eductor could minimize suction difficulties, since operates under pressure. Suction hose might be eliminated. Leaks, if ıy occurred, would not cause failure.

Figure 3 shows the use of an eductor with the 160-gallon, ½- to 1-ton, ıp-on pumper-tanker. The vehicle is located 80 feet above the water urce, and the pump operating at 200 p.s.i. is delivering 20 g.p.m. Of ıe water pumped, 9½ g.p.m. is being delivered down hose line "A" to ıe eductor. The eductor is delivering 20 g.p.m. to the tank through line 3." Fog nozzle on line "C" is delivering 9 g.p.m. The unit will operate ntinuously under this condition, with occasional throttling of flow in ıe "A" to prevent overflow of the tank.

In order to operate without the eductor, a portable pumper would ıve to be set up at the water source. Not having a portable pumper ould, in this particular location, require a round trip of 4¾ miles to low the tanker to reach the water source and draft with usual hard ction hose. An alternative would be the use of two more tankers of e same size shuttling back and forth in order to keep the unit supplied ith water for continuous operation.

F-46437

Figure 3.—Eductor being used with 160-gallon, ½- to 1-ton, slip-on pumper-tanker

Under test conditions, and on larger pumper-tankers, two eductor spaced along line "B" have been used to lift 180 feet.

Table 1 gives values obtained for two of the eductors tested and is an indication of the variation in operating conditions obtainable.

Table 1.—*Maximum output-lift for two eductors*

EDUCTOR E

Pressure	Lift	Water to jet	Water from jet	Pickup water
P.s.i.	*Ft.*	*G.p.m.*	*G.p.m.*	*G.p.m.*
150	35	13	44	31
200	46	15	46	31
250	70	17	47	30
250	100	17	22	5

EDUCTOR C

Pressure	Lift	Water to jet	Water from jet	Pickup water
150	45	13	34	21
200	57	15	36	21
250	80	18	37	19
250	100	18	33	15

The table shows that a pumper that is capable of pumping 17 g.p.m could deliver 30 g.p.m. to the water tank, using water from supplie considerably beyond the range of suction drafting. It also indicates tha

if an eductor were wanted for rapid refill of a fire truck, eductor E would be the proper one to select for lifts up to 70 feet, but C would be selected for lifts of 100 feet.

If the local conditions were such that the primary use was for drafting from, say, a river which was beyond the range of suction lift, and pumping onto fires considerably higher in elevation, another eductor would be selected whereby approximately half of the pumper capacity would run the jet to keep the tank full, and the balance could be pumped onto the fire.

From this short discussion, it is quite evident that selection of "the best eductor" is dependent on certain basic conditions. Adjustable jets are manufactured which permit limited adjustments to overcome these obstacles, but they are complicated and expensive. It might not be out of reason to carry two, or even three, eductors on a fire truck, in order to get maximum performance for all conditions.

One difficulty which exists with the use of eductors for drafting is that some water must be available in the fire truck to start the operation of entraining pickup water. This can be accomplished by installing an auxiliary tank either in the tank or outside, which could be tapped for this purpose; or the internal dip pipe could be equipped with a valve which would not allow the tank to be drained in regular pumping operation, but which could be closed, so that the remaining water could be used for operating the eductor.

SUMMARY

1. By using an eductor properly designed for the pumping unit, water can be pumped from a stream or reservoir which is 100 feet below the fire truck, or from sources 300 feet from possible accessibility because of soft ground, impassable terrain, fences, etc.
2. Output of pumpers can be increased considerably for filling the tank where lifts are 70 feet or less.
3. Where lifts are within range of drafting operations (15 to 20 feet), pumpers could utilize local water sumps and deliver two or three times the pump capacity onto a fire at low pressure.
4. Drafting failures can be minimized by using eductors.
5. Suction hose might be eliminated as necessary tanker accessory.
6. Eductors are inexpensive, simple to operate, and long lived.

Further details concerning the Ejector Suction Booster project and information concerning makes and types of eductors which can be used with pumpers up to 30 g.p.m. at 250 p.s.i. are available at the Arcadia Equipment Development Center, 701 N. Santa Anita Ave., Arcadia, Calif.

PAPER-COVERED PILED SLASH

Lowell W. Ash

District Assistant, Rouge River National Forest

Each fall the Forest Service is likely to experience difficulty in burning piled slash. This is particularly true in the pine-fir transition forests of southern Oregon. Much depends upon favorable weather before, during, and after burning to insure a successful operation. Much labor and equipment has often been necessary to control fires which have gotten away as a result of drying weather conditions after too early slash burning. On the other hand, unsuccessful and expensive burning often occurs because of early and continued rainfall, or postponement of burning until conditions are unquestionably safe late in the fall.

It occurred to the author that this problem could be lessened if some form of inexpensive covering could be provided to protect the piles against excessive moisture until all normal danger of fire spreading to surrounding forest land was over. Hence, an experiment was carried out during the 1950 season, whereby piles were covered with paper as they were made during the summer period. The paper used was Kraft No. 30-30-30, long fibre, waterproof, double-coated, 72 inches wide, with 4,500 square feet per roll. It cost $14.25 per roll at Medford, Oreg.

The slash piles, averaging 6 by 8 feet in size, were covered with the paper when the pile was about three-fourths completed. The piece of paper was not extended down the sides of the pile; it was only large enough to extend to the perimeter at the point where the paper was added. No more than usual care was taken in making the piles compact. However, piles were well rounded before paper was placed on them to insure against low places which might serve to hold water in pockets rather than shed it. The additional slash, that is, the top one-fourth of the pile, held the paper firmly in place. The 600 slash piles constructed in this manner required two rolls of paper. The cost of paper was $28.50, or 4¾ cents per pile.

The 1950 fall precipitation was unusually heavy for southern Oregon, with a total of 6 inches in the slash area by October 19, the day the piles were burned. Two inches of this total precipitation fell the day before burning. Twenty of the piles were purposely left until December 7, at which time light snow was present and the total precipitation had reached 15 inches. While the latter piles started a little more slowly, all 600 burned up clean with little to no chunking. To burn the 600 piles required 4 man-days and 1½ barrels of planer shavings soaked with diesel oil.

It is felt the experiment has demonstrated that this method of protecting piled slash until safe burning conditions are assured promises substantial savings in the over-all job of slash disposal. These savings will result from the following factors: (1) Fewer man-hours are required to burn piled slash. (2) It eliminates present risk of fires escaping, which destroy trees or property and frequently result in excessive control costs. (3) The burning

operation can be completed at a more convenient time for the forest manager, without the need for week-end overtime or the hiring of larger crews to do the job before the piled slash becomes too wet. (4) Planned slash disposal in the partial cut areas can be kept current, with resultant lowering of the over-all hazard, as there will be very little carry-over or unburned slash as a result of extremely wet burning season.

Metallizing the Interior of Water Tanks As A Rust Preventive

The large number of water-using units that have come into the picture in recent ears in forest fire control pose all agencies owning them with a problem of elimnating, as far as possible, corrosion and deterioration in the metal tanks themselves.

An item in the April 1951 issue of Fire Control Notes stressed the possibility of ısing rust preventive solutions or special paints for coating the interior of tanks. \ method which has not yet been mentioned covers a metal spraying process known s "metallizing," which is available commercially under a number of different trade ames.

The equipment required consists of a sand blaster, driven by compressed air; metallizing gun which admits compressed air, oxygen, and acetylene; a three-line ose unit to control these gases; a wire holding stand which contains reels of the articular kind and size of wire being used, and from which it feeds into the gun; set of three gages to control flow of the various gases; and a magnetic thickness age, which determines the thickness of the metallized coating.

A continuous wire is fed through the heat of the oxo-acetylene flame, which at ıe proper temperature volatilizes the metal wire that makes up the spray material. 'he metal is driven onto the surface to be treated in the form of a liquid or molten pray. It cools and solidifies on the surface and makes a permanent coating. Through ıe use of copper, zinc, or stainless steel, the interior of water tanks can be made ractically corrosion proof, and the cost is far less than rust resistant metals in the ody of the tank itself.

The purpose of the sandblasting is twofold. It removes all oxides, dirt, greases, r other foreign material from the surfaces to be coated, leaving them clean and in roper condition to receive the metal coating; it also pits and roughens the surfaces ssuring proper bonding of the spray as it strikes the treated surface.

Cost of treatment varies with the thickness of the coating, the metal being used, nd the technique required for any particular job. Owner of the full kit of equipient can treat steel surfaces for 12 cents per square foot. Work can be done comıercially at costs ranging from 19 cents to $1 per square foot. These figures are ased on applications of zinc to a thickness of 0.010 inch.

Surfaces treated in this way become highly resistant to corrosion. Coatings of nc on steel, thickness 0.010 inch, assure metal life of 30 years without further eatment. Almost any firm material can be metal-sprayed, including wood, leather, ertain fabrics, glass, and ceramic materials.

The method is now in common use in the oil and chemical industries and has xtended to uses such as coating of ships' hulls exposed to corrosive waters. In any ase, surfaces so treated have a life of almost indefinite periods.—G. I. STEWART, *upervisor, Forest Fire Experiment Station, Michigan Department of Conservation.*

FUEL WEIGHTS ON THE OSCEOLA NATIONAL FOREST

David Bruce

Forester, Southern Forest Experiment Station

Fire damage and the fire suppression job are determined in part by how much flash fuel there is in an area. In the southern pine region, heavier fuels (over 1 inch in diameter) increase mop-up but have relatively small effect on the initial control job. In the longleaf-slash pine type, age of rough and stand density are commonly used as general indicators of amount of small fuel. Fuel samples collected in longleaf or slash pine stands on the Osceola National Forest in the winter 1944-45 show how variable the amount of fuel less than 1 inch in diameter can be when thus classified (table 1). Despite the variability, there are well-defined trends that show that these are useful categories.

Table 1.—*Average weight of fuel per acre for open and dense stands, Osceola National Forest,* 1944-45 [1]

Brush type	Open stands, [2] age of rough—				Dense stands, [3] age of rough—			
	1 year	2 years	3-5 years	10-15 years	1 year	2 years	3-5 years	10-15 years
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Palmetto and gallberry . . .	2.5	7.5	4.8	8.4	6.8	8.9	9.7	10.5
Palmetto only .	3.7	6.3	4.1	7.2	6.3	8.3	9.0	20.8
Gallberry only .	4.4	5.8	5.1	7.5	8.0	8.8	8.2	13.0
Average	3.5	6.5	4.7	7.7	7.0	8.7	9.0	14.7
No palmetto or gallberry .	1.5	3.3	3.4	6.9	7.5	4.4	9.4	10.5

[1] Averages were based on air-dry weight of two samples of all material less than 1 inch in diameter that usually burn in headfires under dry conditions. Burnable material included dead palmetto leafstalks, but excluded green leafstalks, and living stems of shrubs and their branches 1/10" or larger in diameter. Each sample included all burnable material on a representative area 1 yard square.

[2] Light stands had no pines over 5 feet tall within 20 feet of the sampling area.

[3] Stands were classed as dense if within 10 feet of the sampling area there were at least four pines 4 inches d.b.h. or larger.

Dense pine stands (see footnotes to table 1) had on the average 4 tons per acre more fuel than open stands. For all density and brush classes, there were about 5½ tons per acre more fuel on the 10- to 15-year-old roughs than on 1-year roughs. Where palmetto or gallberry were present, there were 2 tons more fuel per acre than where these brush species were absent (figs. 1 and 2).

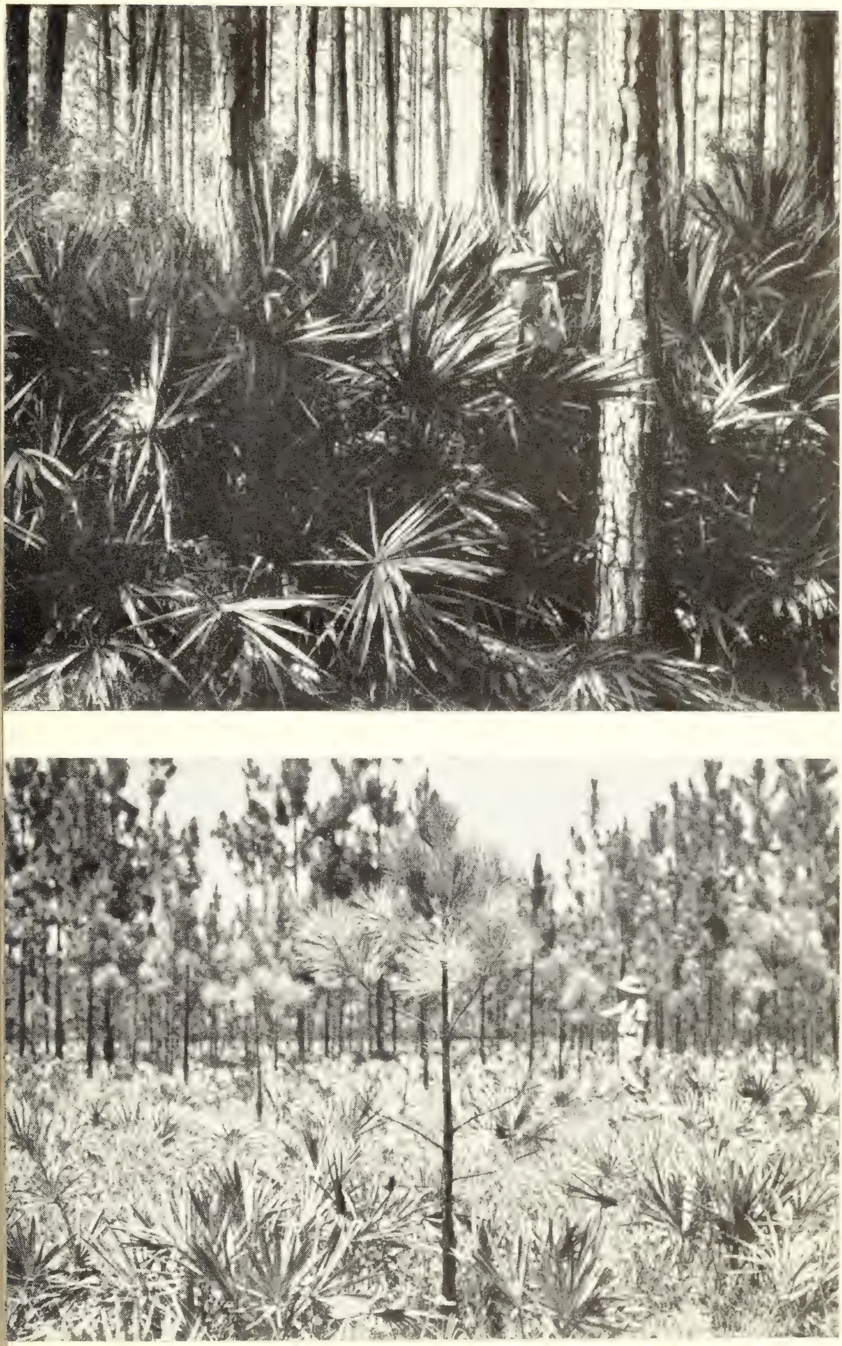

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FIGURE 1.—*Top,* Palmetto (*Serenoa repens* or *Sabal* spp.) when unburned for many years produces maximum amount of fuel. *Bottom,* One growing season after prescribed burning, palmetto has not built up a dangerous accumulation of fuel. The new growth comes from underground rootstocks unaffected by fire.

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FIGURE 2.—*Top,* Gallberry (*Ilex glabra*) unburned for many years is the plant as-sociated with the next heaviest accumulation of fuel. *Bottom,* Like palmetto, gall-berry sprouts vigorously the first season after prescribed burning, but it requires many years to regain the level in the upper view.

The highest and lowest average weights in the table, 20.8 tons and 1.5 tons, agree well with other measurements which indicate maximum fuel accumulations in dense stands of 25 tons per acre, and grass growth in the open of as much as 1 to 1½ tons per acre per year.

Within this range, however, there appear to be several inconsistent measurements. For example, there were greater fuel accumulations in some 2-year roughs than in some 3 to 5 years old, and in the 1-year roughs in dense stands there was more fuel with no palmetto and gallberry than with palmetto. This inconsistency arises in part from the fact that only 2 samples were taken per condition, but probably is even more due to differences in site and past fire history. Moist sites usually produce more vegetation than dry sites and hence accumulate more fuel, even though their decay rates may be slightly higher. For a given period after a fire, areas that have burned hard and often will accumulate less fuel than areas that have not burned frequently.

Where gallberry or palmetto were present they comprised over 40 per cent of the fuel in dense stands and about 60 percent in open stands. With no gallberry or palmetto, more than half the fuel in dense stands was pine needles, and two-thirds of the fuel in open stands was grass.

It is estimated that 50 to 90 percent of the total weights (of fuel less than 1 inch in diameter) sampled in open stands were rapid-drying flash fuels, that is, well aerated dry materials including material up to 1/10-inch diameter that burn rapidly in dry weather, while in dense stands the proportion was 40 to 70 percent. Little or no fuel was found more than 1 foot from the ground on one-year roughs or in areas with no palmetto or gallberry. The biggest increase in fuel more than 1 foot from the ground appears to come in the second year.

Chemical composition of fuel, its arrangement, and rate of change in moisture content were obviously different in the various tabulated conditions. These variables were not measured, but may be as important in their effects on fire intensity as the measured weights.

LIGHTNING FIRES IN THE NORTHERN ROCKY MOUNTAINS

J. S. Barrows

Chief, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station

Lightning fires are a major problem in the northern Rocky Mountains. In the national forests of Region 1 over 75 percent of the fires are lightning-caused. An annual average of nearly 1,200 lightning fires occur on the national forests, and over 400 more occur on lands protected by other agencies. During the last 20 years these fires have burned nearly three-quarter million acres of forest and range land.

In some 40 years of organized fire protection in this region the various fire control agencies have made encouraging progress in their ability to deal effectively with this great load of lightning fires. Continued progress is essential and will depend largely upon gaining a thorough understanding of the nature and peculiarities of these fires. Recently, in an effort to provide this type of information, the Division of Fire Research made an analysis of over 25,000 lightning fires. In accordance with standard Forest Service procedure, essential data on these fires were coded and placed on punch cards to permit machine sorting and tabulating. By this method many factors influencing ignition, behavior, and control could be analyzed singly and collectively. The following are a few of the highlights of the study.

THUNDERSTORM OCCURRENCE

Lightning produced during thunderstorms provides a violent source of heat to ignite forest fires. A lightning stroke may reach a temperature of 30,000° Centigrade. In the northern Rocky Mountains this tremendous surge of heat is seldom accompanied by the downpour of cooling and dampening rain normally associated with thunderstorms. During the summer months "dry" lightning is to be expected. These peculiarities of the storms, coupled with rough topography and large areas of dangerous fuels, are the underlying causes of the severe lightning fire problem in this region.

Thunderstorms cause fires during a 7-month period from April through October. As shown in table 1, during the 15-year period 1931-45 the region had an annual average of 88.13 thunderstorm days, counting only those storms which actually caused fires. In 1944 thunderstorms produced fires on 119 days between May 11 and October 28. During the summer months thunderstorm activity may be almost a daily occurrence. In 1940 lightning fires were started on 53 consecutive days from June 17 to August 8.

Thunderstorm activity reaches its peak in July when lightning fires occur on an average of 24.87 days. August is close behind with an average of 23.00 days, and June is third with 15.33 days. Occasionally a large number of storms may occur in May and September. During a 15-year period there were 2 years when May produced lightning fires on 15 or more days,

and in September there were 5 years with this storm frequency. However, July and August are clearly the most dangerous months from the standpoint of lightning occurrence as well as more critical burning conditions.

TABLE 1.—*Number of days in each month, April through October, when lightning fires have occurred on National Forests in* R-1, 1931-45

Year	April	May	June	July	August	Sept.	Oct.	Total
1931	3	9	21	27	23	11	0	94
1932	0	5	9	15	22	6	1	58
1933	1	2	17	22	21	9	1	73
1934	5	16	17	25	14	8	1	86
1935	0	7	9	23	15	9	6	69
1936	1	13	18	25	27	12	1	96
1937	0	3	19	25	14	14	2	77
1938	0	5	15	21	18	17	3	79
1939	3	10	9	19	17	12	0	70
1940	0	9	23	31	26	26	0	115
1941	4	15	20	29	27	6	0	102
1942	0	8	9	28	30	20	4	99
1943	0	1	5	27	31	17	8	89
1944	0	9	20	30	29	23	8	119
1945	1	6	19	26	31	13	0	96
Total ..	18	118	230	373	345	203	35	1322
Average.	1.20	7.87	15.33	24.87	23.00	13.53	2.33	88.13

OCCURRENCE DENSITY

Variability is the outstanding feature of lightning fire occurrence. In the national forests the 15-year average is 1,164 fires, but annual variations were found to run from a low of 270 to a high of 3,109 fires. More fires may occur in a 10-day period than normally occur in an entire year. In 1940 an all-time record of 1,488 fires occurred in the middle ten-day period of July. During the same period 335 lightning fires occurred in a 24-hour period—a greater number than occurred in the entire year of 1948.

Over 75 percent of the lightning fires occur in July and August. Normally, on about the tenth of July lightning fire activity increases rapidly and continues until a seasonal peak is reached about July 28. After this peak a remarkable midseason slump in occurrence during the first 10 days of August was noted in 11 out of 15 years. Then comes another build-up during the last 10 days of August reaching a peak slightly below that of July. During exceptional years there are great variations to this pattern. On two occasions well over 100 lightning fires occurred during the last 10-day period of May, and on one occasion over 300 fires occurred during the middle 10-day period of June. Late season peaks may likewise occur. Twice in 15 years loads of nearly 200 fires in 10 days came during September.

The bunching of great numbers of fires in a 24-hour period is a critical feature of lightning fire control. Regional loads of 50 or more fires in one day may occur in every month from May through September. During a 15-year period such loads were observed 2 times in May, 5 in June, 35

in July, 30 in August, and 4 in September. In July 1940 a regional load of 50 or more lightning fires occurred for ten consecutive days. On individual national forests loads of ten or more lightning fires in a single day were observed on 354 occasions in a 15-year period. In July 1938 the Kaniksu National Forest had 118 lightning fires in 24 hours. In July 1940 the Kootenai National Forest had more than 50 lightning fires on 3 days in a 10-day period.

The great variations in lightning fire occurrence and the peak loads dictate that flexibility be an essential feature of the fire control organization. Suppression forces must be capable of rapid mobilization to meet off-season loads and expansion to handle peak loads within the normal season. As in warfare, mobility and concentration of force are essential. To meet these requirements fire control planning must be on a regional basis. The cost of manning and equipping an individual forest to meet peak detection and suppression loads throughout a fire season would be prohibitive. Thus a pooling of forces is called for in a regional fire plan incorporating speed, coordination, and great flexibility of action.

LIGHTNING ZONES

The old adage that lightning never strikes twice in the same place doesn't hold true in the northern Rocky Mountains. Contrary to this false belief lightning has struck hundreds of times in several distinct zones within the national forests. Some of the mountain tops are literally covered with the scars of lightning strikes.

In the national forests lying west of the Continental Divide the annual average is 51 lightning fires per million acres. However, in the zones of peak occurrence the annual average is over 175 fires per million acres. In one small zone of approximately 2,300 acres lying on the mountain tops of the Clearwater National Forest lightning fires have occurred at an average annual rate of 440 per million acres over a 15-year period.

These distinct lightning zones are caused by a combination of fuels and elevation. In general, high mountain areas covered with flammable fuels have much greater lightning fire occurrence than similar fuel areas lying at lower elevations. The most intense lightning fire occurrence zones in the high mountain areas are found in the national forests of northern Idaho. As shown in table 2, four of the five national forests in this part of the region have an average annual lightning fire occurrence greater than 100 fires per million acres in the 6000- to 7000-foot elevation zone.

TABLE 2.—*Average annual number of lightning fires*[1] *per million acres by elevation zones, national forests of northern Idaho,* 1936-44

National forest	Elevation zone							Forest average
	1000-1999 feet	2000-2999 feet	3000-3999 feet	4000-4999 feet	5000-5999 feet	6000-6999 feet	7000 feet & over	
Clearwater	....	21.64	77.26	136.41	177.12	177.05	440.92	136.79
Coeur d'Alene	....	26.76	49.78	83.96	85.89	156.21	....	57.49
Kaniksu	7.36	29.60	53.11	62.70	87.30	123.19	....	53.93
Nezperce	10.76	26.78	39.75	74.57	109.78	98.56	66.90	74.46
St. Joe	....	52.01	39.95	60.51	80.49	190.59	....	63.93

[1] Basis: 7,377 fires.

The importance of fuels in governing lightning fire occurrence is illustrated in the national forests lying east of the Continental Divide. Here the most intense lightning fire zone is at the lowest elevation where fuels are principally ponderosa pine and grass. In this part of the region the mountain top areas often have only scattered areas of flammable fuels interspersed with rocky outcroppings and alpine meadows. The average annual lightning fire occurrence per million acres in the national forests lying east and west of the Continental Divide is as follows:

	Average annual lightning fire occurrence per million acres	
Elevation zone (feet):	*Eastern Forests*	*Western Forests*
1000-1999	....	10.95
2000-2999	....	32.53
3000-3999	30.45	50.79
4000-4999	8.10	66.99
5000-5999	10.12	73.72
6000-6999	6.96	69.26
Over 7000	5.53	36.00

Snags are highly vulnerable to lightning fires. In a study of nearly 12,000 fires it was found that over three times as many fires started in snags as in green tree tops. The ratio of snags to green trees is not known. However, there are obviously a much larger number of green trees than snags in the forests of this region. Therefore, in view of the higher ignition rate in snags, they are clearly an important factor. This relationship is further illustrated by the fact that old burns where snags predominate have an average annual occurrence rate of 190 fires per million acres as compared to 40 in green forests.

LIGHTNING FIRE DETECTION

In planning detection operations the daily period of peak fire occurrence is an important consideration. Lightning may strike and cause fires at any hour of the day. However, in the northern Rocky Mountains the late afternoon and early evening hours are clearly the period of greatest lightning occurrence, while the midmorning hours have the least lightning activity. The most important 8-hour period is from 2 to 10 p. m. In the national forests west of the Continental Divide over 60 percent of the lightning fires occur during this period. Concentration during these hours is even more intense on the forests east of the divide where 75 percent of the lightning fires occur between 2 and 10 p. m. Peak occurrence in both zones is from 4 to 6 p. m. Night detection is more important than generally recognized. More lightning fires occur during the hours of darkness than during the morning daylight hours.

Lookouts are more efficient in detecting lightning than man-caused fires. Over 83 percent of the lightning fires falling within the seen area of manned lookouts are first discovered from those stations as compared to only 43 percent for man-caused fires. However, speed of detection is slower for lightning than man-caused fires. Elapsed time from origin to discovery is greater than 12 hours for 45 percent of the lightning fires as compared to only 25 percent for man-caused fires. Likewise, nearly twice as many lightning fires are hangovers with a discovery time of over 48 hours.

This study of lightning fire detection has shown the importance of taking a fresh look at hours of work for detectors and general detection methods. The afternoon and early evening hours are normally the most important for detectors to be on the job. To increase the efficiency of night as well as daylight detection fire finders equipped with accurately calibrated azimuth and vertical scales need to be used in conjunction with matched panoramic photographs. Because of the difficulty of night detection a thorough scanning of the country is essential in the early daylight hours and especially during periods of critical fire weather. On aerial detection units it is important for aircraft and pilots to be capable of making safe flights after storms during the late afternoon and early evening hours when turbulent air may prevail. In all cases it is essential to correlate the detection plan with a system of measuring and rating fire danger in order to economize on detection costs and to promote efficiency.

LIGHTNING FIRE SUPPRESSION

On the national forests over 84 percent of the lightning fires are held to class A size. In spite of this good record lightning fires present many special and difficult suppression problems. The average size per lightning fire is 46 acres. Only 4 percent of these fires can be reached by roads. The balance requires at least a part of the travel by other means. Only 34 percent of the lightning fires are reached within 1 hour. Over 22 percent of the lightning fires require more than 4 hours travel time, and 11 percent require more than 8 hours. Nearly 50 percent involve travel distances of over 5 miles and 25 percent over 10 miles.

The smoke jumper organization, designed primarily to control backcountry lightning fires, has made a good record in holding burned area to a minimum. The average size per smoke-jumper lightning fire is 11 acres. However, it is recognized that this record has been made during a 10-year period of phenomenally easy fire danger. In every dangerous or critically dry season in the region's history lightning fires have escaped control to burn large areas. On two occasions during the past 20 years individual lightning fires have reached sizes of over 75,000 acres, and on one occasion over 175,000 acres. During the same period over 100 lightning fires reached class E size.

While the smoke jumper has reduced the probability of disastrous burns in the future, the lightning fire suppression problem is far from being solved. The smoke jumper is primarily a hand-tool firefighter and operates under the same handicaps as any smokechaser. Ten years' experience has shown that 18 percent of the smoke jumper lightning fires are in high or extreme rate-of-spread fuels and that 11 percent of these fires are running, spotting, or crowning at first attack. Successful control of such fires demands something more powerful than hand-tool firefighting. The backcountry fire control man, like the infantryman, needs help. Future fire research and equipment development must point toward the improvement of basic fire suppression methods.

A TEMPLATE FOR PREPARING AND CHECKING FIRE REPORTS

G. M. Wilkinson

Assistant Forest Supervisor, Kisatchie National Forest

In the Southern region of the U. S. Forest Service the dispatcher gathers the pertinent information and prepares the individual fire report, Form 929. The report is approved by the district ranger, forwarded to the supervisor's office where it is checked for errors, and then sent to the regional office for completion.

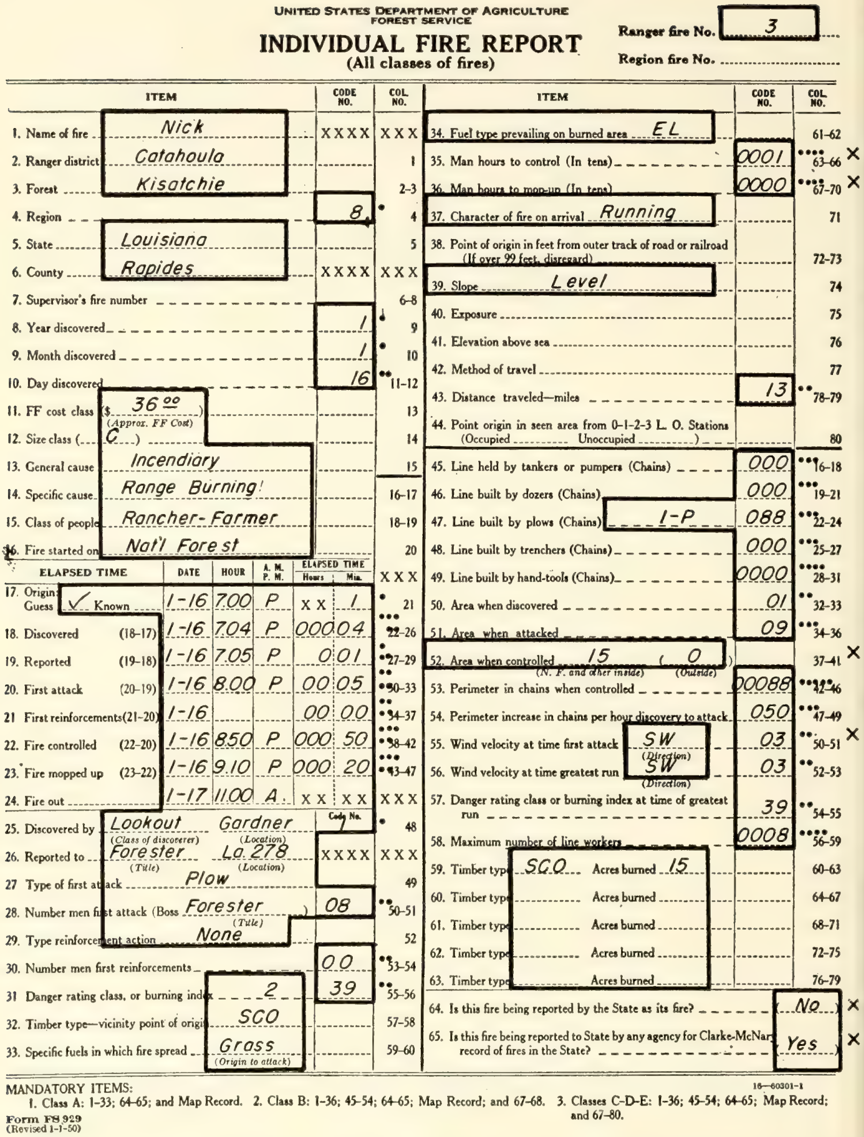
The fire report carries a "Code Number" column where information is coded for use on an IBM punch card machine. All national forest fire statistics are maintained on punch cards in the Washington office. Some of the information coded is placed on the report in the field offices and some at supervisor or regional offices. This made fire reporting by the field offices rather difficult and time consuming since it was necessary to constantly refer to voluminous instruction.

To assist field officers with this problem a template of clear plastic was designed with openings in the "Item" and "Code Number" columns where entries were to be made by the reporter. This template can also be used in the supervisor's office for checking reports prepared on the ranger districts. This device proved to be satisfactory and, while no studies have been made locally of time saved by its use, it has saved some time, and fire reports from the field are generally correctly prepared.

Directions for using template.—Place template over blank Form 929. Complete only the spaces where there is an opening in the template. Where the opening occurs over a line in the "Item" column, the information is written there; where the opening is in the "Code Number" column, the information, coded, is placed there. In one or two instances, openings occur in both columns and in such cases both entries are made.

The black dots at the right of the template openings in the "Code Number" column indicate the number of digits required for proper coding. For instance, item 10 requires two digits in the code column; item 53 requires five. The only exception occurs in items 18 to 23. These items require a code number in both the hours and minute columns. The black dots for these items are in two lines, the upper row indicating the number of digits (code) required in the hours column, the lower row indicating the number of digits required in the minutes column. Thus, if elapsed time on line 20 is 1 hour 55 minutes, it would be coded 01 in the hours column (two dots), and 55 in the minutes column (two dots).

For Class A fires complete all uncovered items on left side of template (items 1-33)and all items marked × on the righthand side (items 35, 36, 52, 55, 64, 65). For Class B, C, D, and E fires complete all items uncovered by the template.



UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INDIVIDUAL FIRE REPORT
(All classes of fires)

Ranger fire No. 3
Region fire No.

ITEM		CODE NO.	COL. NO.
1. Name of fire	Nick	XXXX	XXX
2. Ranger district	Catahoula		1
3. Forest	Kisatchie		2–3
4. Region		8	4
5. State	Louisiana		5
6. County	Rapides	XXXX	XXX
7. Supervisor's fire number			6–8
8. Year discovered		1	9
9. Month discovered		1	10
10. Day discovered		16	11–12
11. FF cost class	($ 36.00 (Approx. FF Cost))		13
12. Size class	(C)		14
13. General cause	Incendiary		15
14. Specific cause	Range Burning		16–17
15. Class of people	Rancher-Farmer		18–19
16. Fire started on	Nat'l Forest		20

ELAPSED TIME	DATE	HOUR	A. M. P. M.	ELAPSED TIME Hours	ELAPSED TIME Min.	XXX
17. Origin: Guess / ✓ Known	1-16	7.00	P	XX	1	21
18. Discovered (18–17)	1-16	7.04	P	000	04	22–26
19. Reported (19–18)	1-16	7.05	P	0	01	27–29
20. First attack (20–19)	1-16	8.00	P	00	05	30–33
21. First reinforcements (21–20)	1-16			00	00	34–37
22. Fire controlled (22–20)	1-16	8.50	P	000	50	38–42
23. Fire mopped up (23–22)	1-16	9.10	P	000	20	43–47
24. Fire out	1-17	11.00	A	XX	XX	XXX

ITEM		CODE NO.	COL. NO.
25. Discovered by	Lookout (Class of discoverer) Gardner (Location)	7	48
26. Reported to	Forester (Title) La. 278 (Location)	XXXX	XXX
27. Type of first attack	Plow		49
28. Number men first attack (Boss Forester (Title))		08	50–51
29. Type reinforcement action	None		52
30. Number men first reinforcements		00	53–54
31. Danger rating class, or burning index	2	39	55–56
32. Timber type—vicinity point of origin	SCO		57–58
33. Specific fuels in which fire spread	Grass (Origin to attack)		59–60

ITEM		CODE NO.	COL. NO.
34. Fuel type prevailing on burned area	EL		61–62
35. Man hours to control (In tens)		0001	63–66
36. Man hours to mop-up (In tens)		0000	67–70
37. Character of fire on arrival	Running		71
38. Point of origin in feet from outer track of road or railroad (If over 99 feet, disregard)			72–73
39. Slope	Level		74
40. Exposure			75
41. Elevation above sea			76
42. Method of travel			77
43. Distance traveled—miles		13	78–79
44. Point origin in seen area from 0-1-2-3 L. O. Stations (Occupied ... Unoccupied ...)			80
45. Line held by tankers or pumpers (Chains)		000	16–18
46. Line built by dozers (Chains)		000	19–21
47. Line built by plows (Chains)	1-P	088	22–24
48. Line built by trenchers (Chains)		000	25–27
49. Line built by hand-tools (Chains)		0000	28–31
50. Area when discovered		01	32–33
51. Area when attacked		09	34–36
52. Area when controlled	15 (N. F. and other inside) (0 (Outside))		37–41
53. Perimeter in chains when controlled		00088	42–46
54. Perimeter increase in chains per hour discovery to attack		050	47–49
55. Wind velocity at time first attack	SW (Direction)	03	50–51
56. Wind velocity at time greatest run	SW (Direction)	03	52–53
57. Danger rating class or burning index at time of greatest run		39	54–55
58. Maximum number of line workers		0008	56–59
59. Timber type SCO Acres burned 15			60–63
60. Timber type ... Acres burned			64–67
61. Timber type ... Acres burned			68–71
62. Timber type ... Acres burned			72–75
63. Timber type ... Acres burned			76–79
64. Is this fire being reported by the State as its fire?	No		
65. Is this fire being reported to State by any agency for Clarke-McNary record of fires in the State?	Yes		

MANDATORY ITEMS:
1. Class A: 1–33; 64–65; and Map Record. 2. Class B: 1–36; 45–54; 64–65; Map Record; and 67–68. 3. Classes C-D-E: 1–36; 45–54; 64–65; Map Record; and 67–80.

Form FS 929
(Revised 1-1-50)

16—60301-1

FIGURE 1.—Template in place for checking fire report prepared in field. Note error in the code number column disclosed by template; item 51 should be coded 009.

Directions for making template.—(1) Prepare a pattern by blocking out on a blank 929 each line in the "Item" column and each line in the "Code Number" column which, under existing instructions, is to be reported on by the ranger district.

(2) With knife or razor blade, remove blocked out sections, leaving sufficient marginal material so the pattern will remain in one piece. Recheck pattern for accuracy before cutting template.

(3) Select a piece of clear plastic the same size as Form 929. Plasticiele, 30/1000 inch in thickness, is entirely satisfactory. In this weight, the

material is sufficiently rigid for the purpose, and yet is not too difficult to cut. Place the sheet of plastic over the pattern, lining up the edges of the plastic and the pattern. Then fasten to a table or drawing board with tape. Using a straightedge, score the outline of each opening in the pattern on the plastic. A sharp ice pick makes a good tool and the scoring should be deep. After this has been completed on one side, turn plastic sheet over and score the reverse side. If the scoring on each side is deep enough, the section to be removed can be broken out. Edges should be smoothed with an emery board or small file.

(4) If desired, the number of digits needed in the "Code Number" column can be indicated by dots, as shown on the template illustrated in figure 1. This information is also available in the "Column Number" column on the 929 and may be read direct. For instance, opposite item 10, the figures 11-12 appear in the "Column Number" column indicating two digits required in the "Code Number" column; opposite item 53 the numbers 42-46 appear, indicating 5 digits required. We have found the use of dots to indicate the number of digits to be more satisfactory.

This device has been tested under field conditions in Region 8 and approved for region-wide use. It can be adapted easily to the needs of the several Forest Service regions by changing the pattern to coincide with regional instructions. Its use should save time and improve accuracy in preparing and checking fire reports in the field.

While this discussion has been devoted to the use of the template in conjunction with Forest Service fire reports, it is possible that the idea could be applied to preparation of reports by other fire control agencies.

BATTERY CONSUMPTION BY LOOKOUT-REPEATER TYPE RADIOPHONE

Willie I. Haynes

Radio Technician, Region 7, U. S. Forest Service

"It must take an awful lot of batteries to keep these things in operation," is the usual remark after someone inspects the "works" of the new FM radiophones with automatic repeaters now in use on the Jefferson and George Washington National Forests. The "works" is comprised of 13 or 14 relays, many transformers, resistors, etc., and from 28 to 30 tubes that range in size from that of a half-burned cigarette to the size of an average thumb.

Actually, the FM lookout station radiophones with automatic repeaters are conservative battery consumers. This point could have been proved in a scientific manner with fancy graphs, but due to many factors, such as variations in battery quality, shelf life of batteries, and atmospheric conditions that affect batteries, it was felt exact information might be misleading. Therefore, our method was simply that of comparing the number of battery replacements with the general use the radiophones received from time of installation in 1949 (two installed in 1948) until the close of the 1950 fall fire season on the two forests.

In Region 7, FM radio equipment is not used as it is in some of the other regions of the Forest Service. For example:

1. It is not used on a year-round basis for both administrative and fire control purposes. It is used only for fire control which includes presuppression and suppression communications in the regular forest fire seasons.

2. Radio, on the two national forests equipped with FM radiophones, is used intermittently during approximately 4½ months each year. The period of forest fire danger is divided into two seasons, one beginning in the spring about March 1 and ending about May 15, and the other beginning in the fall about October 15 and ending about December 15. The lookout stations are manned during these seasons on days of Class 3 and higher fire danger. The number of these days in the spring season varies, but the usual number is from 50 to 60 while in the fall it may be as high as 32. In other words, radio is used between 80 and 90 days each year.

3. Radio, of course, is only used when the lookout towers are manned. If the day starts with a Class 2 fire danger and increases to a Class 3, the stations on continuous stand-by operate on a schedule until the fire danger reaches a Class 3 day. This sometimes reduces the continuous stand-by period to 4 hours per day of Class 3 danger.

4. As a rule only key lookout stations on each district are on stand-by on Class 3 and higher fire dangers. The lookout stations of secondary importance are operated on a schedule. They go on stand-by for 10-minute periods every 30 minutes to receive messages from the key stations or to transmit when necessary. These stations go on continuous stand-by when (a) the fire danger reaches Class 4; (b) when personnel working in the vicinity need the station as a means of contacting the district offices.

5. Coded signals of the ten-series type are used on two districts of Jefferson National Forest. The forest plans adoption of these signals over the entire forest by the spring of 1951. Because of their brevity, coded signals permit the transmission of routine messages but reduce transmission time and resulting battery consumption.

To the outsider who is not familiar with Region 7, it may appear that the use of radio is considerably restricted. This is actually not the case. The forests using the FM equipment were responsible for developing the systems and methods in use, and have adopted them to meet their needs. Their objective is to conserve the batteries until they are needed most, which is on a forest fire.

With the foregoing information on how radio is used in Region 7, it is easier to evaluate the results of the survey made at the close of the 1950 fall fire season. Table 1 shows only the number of replacement batteries and does not include the original batteries when the radiophones were installed. If a replacement is not indicated opposite the name of a station, the original batteries are still in use.

On the basis of the survey of the number of battery replacements, we believe it can safely be said that even though the FM lookout radiophones have approximately four times as many tubes as the AM lookout station radiophones, they are twice as easy on batteries.

TABLE 1.—*Number of battery replacements for FM lookout station radiophones with repeaters, after installation in* 1949 *until close of* 1950 *fall fire season, at stations on two* R-7 *forests*

GROUP A [1]

Station	Radiophone installation date	Receiver A	Audio A	Receiver B sets	Transmitter A	Transmitter B sets
On continuous stand-by:						
High Knob	Aug. '49	0	0	0	0	0
Quebec	Mar. '49	1	1	2	1	1
Walker Mountain	Nov. '48	2	1	1	1	1
Apple Orchard .	Mar. '49	1	0	1	1	1
Bald Mountain .	Sept. '49	1	0	0	1	0
Duncan Knob ..	Oct. '49	0	2	2	0	2
On a schedule:						
Olinger Top ...	Aug. '49	0	0	0	0	0
Jasper Cliff	Aug. '49	0	0	0	0	0
Feathercamp ...	Mar. '49	1	0	0	1	0
Flat Top	Nov. '48	1	0	1	2	1
Jones Knob	Mar. '49	1	0	1	1	1
Allen Field	Sept. '49	0	0	0	0	0
Brushy Mountain	Oct. '49	0	0	0	0	0

GROUP B

Station	Radiophone installation date	A battery sets	B battery sets
On continuous stand-by:			
Bald Knob	May '49	2	2
Morning Knob .	Oct. '49	2	[2] 0.4
On a schedule:			
Earn Knob	Sept. '49	0	0

[1] Because the radiophones are the product of two manufacturers, the battery complements are different, and the table is grouped accordingly.

[2] 10 to a set.

FIRE DANGER MANNING GUIDE

MERVIN O. ADAMS
Forest Dispatcher, Shasta National Forest

During the past 2 years, the Shasta National Forest has been operating its fire force, on off-duty days, through the use of a Fire Danger Manning Guide.

This guide was designed by Dispatcher Adams to eliminate the guess work whenever it was necessary for a district ranger to decide if ground and initial attack forces and lookouts were needed on the off-duty days. The use of the manning guide has eliminated the payment of overtime during those periods when the fire danger did not warrant using overtime.

The manning guide was designed to cover only the man-caused risk and occurrence. During periods of lightning storms or storm predictions, heavy drains on district forces for off-district or forest fires, continual long periods of high or very high danger, or unusual high use, it is necessary for the district office to explain to the supervisor's office the conditions which warrant consideration. The supervisor's office approves all justifiable requests to meet the unforeseen conditions, or obtains approval from Regional Fire Control. During the normal run of the season the district ranger, who has an approved copy of the manning guide, has the authority to hold on duty and work those positions called for by the danger rating.

The manning guide is mimeographed on letter-size sheets (fig. 1). The heading is in three parts: Station location, position, and danger. The first two are self explanatory. The third, danger, is broken into the five classes of danger used in Region 5: Low, medium, high, very high, and extreme. Under each danger class are two blank spaces, one for percent of the season total in that class, and the other the number of off-duty days expected to fall into each danger class.

As this system has not been used for a long enough period to determine a yearly average, it has been necessary to use the preceding year's fire-danger rating to arrive at the percent of time for each class of danger. To arrive at these figures for ground and initial attack forces for the period of July 1 to October 10, we take from the fire-danger rating form for each district the total number of days for each danger class and convert it to percent.

The next step is to determine the total number of off-duty days between July 1 and October 10. This is then broken into the number of days that can be expected in each danger class by using the appropriate percent.

The next step, after arriving at the percent of time and number of days, is to list the location of each station and the position or positions at each location for each ranger district. After these entries are made, we determine when each position is authorized to go on duty, on the off-duty days. No authorization for overtime is allowed for low or medium days as our regular force should and must be able to cope with any man-caused fires during these two classes of danger.

GROUND AND INITIAL ATTACK FORCE
7/1 to 10/10
FIRE DANGER MANNING GUIDE

RATING AREA 5

MC CLOUD District
1959 Season

Station Location	Position	DANGER Low 9 % 3 Days	Medium 20 % 6 Days	High 55 % 18 Days	Very High 16 % 5 Days	Extreme 0 % Days
MCCLOUD	FIRE CONTROL ASSISTANT	0	0	0	0	
"	DISPATCHER	0	0	0	0	
"	SUPPRESSION CREW FOREMAN	0	0	0	ON DUTY	
"	TANK TRUCK OPERATOR	0	0	0	ON DUTY	
"	CREWMEN (2)		ALTERNATE DUTY ONLY			
BARTLE	SUPPRESSION CREW FOREMAN	0	0	ON DUTY	ON DUTY	
	CREWMEN (2)		ALTERNATE DUTY ONLY			
HARRIS SPRINGS	FIREMAN	0	0	ON DUTY	ON DUTY	
"	" CREWMAN (1)	COOP. POSITION - NO OVERTIME ALLOWED				
MEDICINE LAKE	FIREMAN	0	0	0	ON DUTY	
	TOTAL DAYS ALLOWED			36	25	
	COST BUDGETED			$571.12	$401.25	

Approved by:
S/ R. C. Bangsberg
Acting Forest Supervisor

FIGURE 1.—Manning guide as used for ground and initial attack forces.

To determine what positions are to be on duty on the high days, we first look at the station location. If there is more than one fireman or a crew foreman and a small crew at a given location, no overtime is allowed for a high day, i.e., at a headquarters location there is usually a fire control assistant, dispatcher, suppression crew foreman, tank truck operator, and one or two crewmen. With this manpower available it is necessary for the district to set up tours of duty, by alternating the off-duty days for positions, so that 7-day regular time coverage is given.

At locations where there is only a foreman and a small crew or where there is a single fireman, overtime is allowed on high danger days. This is

necessary to allow for full coverage during high days. If the position is in the high country, or so-called low risk areas, no overtime is allowed on high days.

On very high danger days, we begin to bring our maximum striking force into action. We have reached the point where it is necessary to hit and control a fire in the shortest time possible or have a large fire to fight. At district headquarters the foreman and tank truck operator are authorized to go on duty in this danger class. All single position or small crew stations are activated.

If any days fall into the extreme danger class, all of the striking force is placed on duty. All cooperators are contacted and every means is taken to prevent fire. If a fire should start on an extreme day, we have the total district force ready to roll, plus the power of rapid reinforcement to back up the initial attack force.

The final step is to arrive at the cost of financing this plan. We determine the daily overtime rate for each position, multiply this by the number of days allowed, and come out with the final cost for budgeting purposes.

The only positions that are part of the striking force but are not authorized for lieu day duty are the crewmen. Each district alternates the crewmen's tours of duty so that the maximum possible number are on duty each day of the week. Whenever the danger goes into a prolonged very high period and during extreme days, the Forest fire control officer takes a critical look at the entire Forest resources to determine if it is necessary to place crewmen on duty during the off-duty days. If conditions warrant such a move, approval is requested from Regional Fire Control, with emergency FFF financing such a move.

When a position is placed on duty, because of the danger conditions, the incumbent does not sit at his station and wait for a fire. He is instructed, by his district office, to perform certain duties such as roving patrol, contacts with recreationists, mills, logging operations, railroad officials, and employers, or working on presuppression or project jobs. The only time that a person may be held at his station is during the extreme danger, and then only the suppression crews, dispatchers, and stand-by fire cat operators are so held. The rest of the force is assigned to prevention work.

Although it takes time to figure the determining factors, the end result is that the district office has a readily available form which can be consulted daily to determine what organization is needed to cover the predicted danger for the next day.

The manning guide form is also used to set up the required number of positions needed to furnish detection for 7 days each week. The percentage factor for each class of danger from the opening date of the detection season, usually June 1, to October 10 is calculated. We again determine the number of off-duty days during the detection season and apply the percentage factor in order to set up the number of off-duty days that can be expected for each class of danger.

The difference between ground force and detection is that we need 7-day coverage by lookout. This in turn means that lookouts or alternates are on duty during all classes of danger.

We use the same method for detection as we do for ground forces to arrive at our cost figure for budgeting purposes.

It is said that necessity is the mother of invention. This is very true in the Forest Service. We feel that the Danger Manning Guide is one answer to the policy of maximum reduction of overtime expenditure. The guide

has done away with the former hit or miss method of determining initial attack force needs and manning. It brings about equality of emergency manning among the districts and does away with one being manned Low while one is manned High for a corresponding danger.

Published Material of Interest to Fire Control Men

Are You Burning Dollar Bills?, by P. W. Schoen. Prog. Farmer. Feb. 1951.

A Story of Radio and Forest Fires, by A. B. Meyer. Mo. Conserv. Jan. 1951.

A Way to Prevent Woods Fires; Costs So Little Yet Saves So Much, by L. T. Nieland. Fla. Grower. Feb. 1951.

Observed Effects of Prescribed Burning on Perennial Grasses in the Ponderosa Pine Forests, by Harold Weaver. Jour. Forestry. April 1951.

Fire As An Ecological Factor in the Southwestern Ponderosa Pine Forests, by Harold Weaver. Jour. Forestry. Feb. 1951.

Fire Control at Northwest Bay, by H. Weatherby, Brit. Columbia Lumberman. Jan. 1951.

Fire Effects of Bombing Attack. 45 pp., illus. Published by Civil Defense Liaison Office, Gov. Print. Off.

Fire Protection on Your Outfit, by H. Weatherby, Brit. Columbia Lumberman. Dec. 1950.

Fire, Site and Longleaf Height Growth, by David Bruce. Jour. Forestry. Jan. 1951.

Forest Fire Smoke of September 1950, by Howard W. Lull. Jour. Forestry. April 1951.

Forest Protection, by H. T. Gisborne. *In Fifty Years of Forestry in the U. S. A.* Published by Soc. Amer. Foresters.

Honeymoon Lookout, by Helen McDonald Clark. Amer. Forests. April 1951.

More About Pines and Fire, by H. H. Chapman. Jour. Forestry. April 1951.

Northeastern Logger's Handbook, by Fred C. Simmons. U. S. Dept. Agr. Hdbk. 6. 1951. Chapters on small tools, power cutting tools, and tractor use.

Remember the Ember. Amer. Forests. April 1951.

Slash Problems in British Columbia, by R. G. McKee. Brit. Columbia Lumberman. Jan. 1951.

Slip-On Tanker—One Half to One Ton. A proposed standard. U. S. Forest Service. [Processed.] 1951.

Smokey is Convincing a Nation: Only You Can Prevent Forest Fires, by Clint Davis. Amer. Forests. April 1951.

Teamwork in State Forestry (Fire Prevention in Georgia), by C. Elliot. Amer. Forests. July 1950.

Twenty Years Without Fire Protection, by K. B. Pomeroy. Forest Farmer. Dec. 1950.

COOPERATORS' FIRE FINDERS

M. C. Howard
Forest Supervisor, Ouachita National Forest

Cooperators' fire finders can supplement a lookout tower detection system or may even replace it. Strategically located to take advantage of good views, telephone service, and cooperative residents, finders are readily manned for fire detection (fig. 1). Properly oriented fire finders, accurately spotted on fire control maps, make accurate fire locations possible without intimate knowledge of the territory or of local landmarks.

Figure 1.—A cooperator taking a bearing.

The cooperator's or warden's fire finder was a $200 project of the 1939 Fire Control Equipment Conference and was assigned to the author, then in Region 7. The pattern and first fire finders were cast in brass by an Indiana firm. The first supply cost $8.15 each and the George Washington National Forest was the distribution and purchasing agent. When the price of brass tripled, arrangements were made with an Arkansas brass works to cast some in aluminum at about the original price (fig. 2). These critical metals have made production difficult and makeshift devices may have to be used for the present. The pattern remains in the custody of the George Washington National Forest.

The Fire Control Equipment Committee in approving the fire finder project made this requirement: "To be attractive, with special emphasis

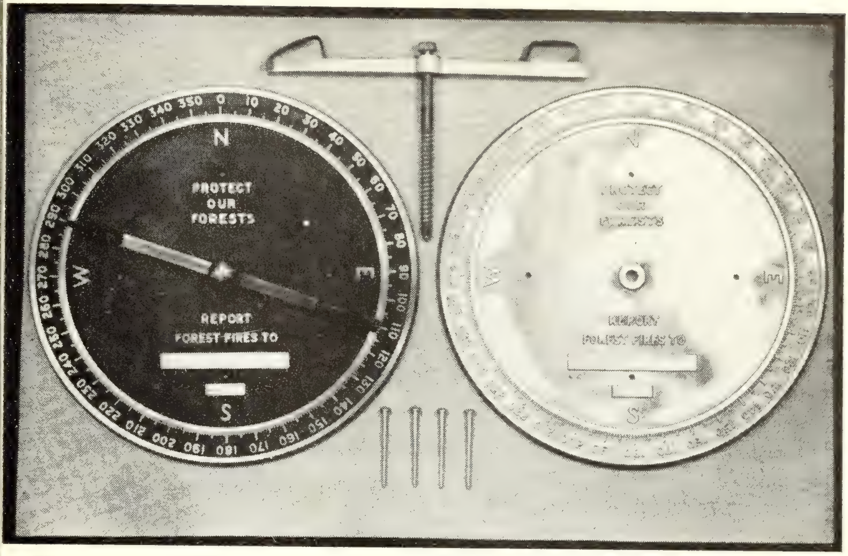


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FIGURE 2.—Assembled brass and unassembled aluminum fire finders.

on educational and prevention value." These fire finders are just that when installed at a service station or at a recreation resort. A weatherproof chart identifying prominent landmarks by azimuth reading enhances the value and utility of such an installation.

Discarded Water Tank Converted Into Substantial 50-Foot Fire Tower

We are pleased with the results of our efforts to construct a much needed fire tower out of what was destined to become scrap iron. When we learned that an abandoned water tank on one of our State parks was to be torn down and sold for scrap we immediately made arrangements to obtain the materials by agreeing to dismantle and remove the tank. This initial step was accomplished in short order by two of our fire crews. All of the steel work and most of the cypress tank was salvaged in good condition and later used in tower construction.

The reassembly was relatively simple. Concrete footings were poured to the same dimensions as on the original tank. By marking the steel work as it was dismantled we were able to reassemble the structure without too much difficulty. From here we were on our own in substituting a cab for the original cypress tank that sat on the steelwork. This was finally worked by bolting heavy oak floor joists to the support legs and constructing a conventional size wooden cab on this base. Some of the salvaged cypress lumber from the tank was used here for framing and subflooring. The cab is boxed and sealed inside with center-matched pine flooring. The roof is of composition shingles and the windows are standard industrial steel casements. The stairways and landings are of 2-inch oak and the handrails are 1-inch galvanized iron pipe.

The cost of materials for this construction was approximately $250. This included boxing, flooring, roofing, windows, stairways, handrails, cement and paint. All labor was by regular fire crew personnel.—EARL M. BRADEN, *District Forester, Tennessee Division of Forestry.*

SAFETY ON THE FIRE LINE

C. D. Blake
Safety Officer, Northern Region, U. S. Forest Service

When I look back over my 35 years of experience in fighting forest fires in the Northern Rocky Mountains, I think of the many improvements which have been made in safety practices. Early-day fire fighting used to be considered a "he-man job" where nothing much could be done to prevent injuries or fatalities to fire fighters. Many times it was necessary for the overhead and fire fighters to tough it out for weeks and some times for months, under gruelling conditions without relief or replacements.

Fire fighting is still a "he-man job." But fortunately for the present-day and future forester, specially designed equipment, rapid transportation facilities (including aerial services), better organizations and dispatching, and improved generalship training, make it practical to provide needed relief and replacement for overtaxed overhead and fire-line workers. Fire control agencies are doing a much better job of incorporating accident prevention into planning, training, supervision, and inspection.

More consideration is being given to a potential fire boss's mental, as well as physical, ability to withstand the severe strain which is invariably present when a fire is large and complex. Management has also learned that, after an extended fight to control a severe fire, there may be a letdown on the part of the fire fighters. Under such circumstances it may be advisable to provide relief or replacements for prolonged mop-up action.

Fire control agencies who adopted the "step-up," the "modified step-up," or some other modern method of organizing and controlling fire fighters, have found that much greater and safer work output is possible.

Many fire control agencies are providing for the pooling of their fire suppression resources. This is decidedly a step in the right direction. Such cooperative arrangements provide for a greater number of experienced and trained overhead personnel, who will be available to relieve shortages within hard-hit fire areas. While there has been much progress in methods that reduce injuries and fatalities on the fire line, there are still some phases of the safety job in need of improvement. I, for one, should like to see the following safety points given special consideration in future plans of operation.

1. Established medical requirements and facilities that assure periodic physical checkups of regular overhead personnel subject to call for strenuous fire duty.

2. Critical screening of fire fighters, at the time of hire, again before reaching the fire, and again at the fire line. More critical attention to suitable footwear and other clothes, and to the physical fitness of the fire fighter. (This should be particularly the case if the men are to be assigned to rough terrain, to night work, or to hot fire sectors. Most fire bosses

recognize the fact that physically unfit or improperly clothed men retards rather than increases fire-work output.)

3. Fire-line workers and overhead provided with appropriate safeguards such as suitable tools and equipment, hard hats, and first-aid facilities. Tractor operators protected by canopy guards.

4. Special project fire safety officers used much more often in dangerous areas during critical fire weather, and where 100 men or more are employed on a fire. (A fire safety officer, to serve efficiently, must be planned for, incorporated in the fire organization, and given sufficient training in advance of first assignment.)

State Fire Control Equipment Increased

A combined inventory as of July 1950 shows a substantial increase in State-owned fire control equipment over a similar 1945 inventory. The inventory includes the 43 States engaged in the Clarke-McNary cooperative protection. In 1950 360,264,000 acres of State and privately owned forest lands were included, while in 1945 the area protected was 303,000,000 acres. A comparison of the 1945 and 1950 inventory follows:

		1945	1950	*Percent of change*
Protection roads	miles	33,710	34,309	+ 1.8
Metallic telephone lines	do	22,137	25,041	+ 13.1
Grounded telephone lines	do	17,992	9,937	— 44.8
Steel and stone lookout towers	number	1,867	2,301	+ 23.2
Wooden lookout towers	do	546	631	+ 15.5
Tree lookout cabs	do	105	94	— 10.5
Tanker trucks	do	1,379	2,045	+ 48.3
Transportation trucks	do	1,521	2,468	+ 62.3
Tractors	do	486	935	+ 92.3
Graders, bulldozers, and trailers	do	219	275	+ 25.6
Mechanized plows	do	380	1,093	+187.6
Portable power pumps	do	1,296	1,678	+ 29.5
State-owned airplanes	do	5	24	+380.0
Radios	do	2,172	5,570	+156.4

The 1950 inventory shows that 12 States operate their own aircraft; in 1945 there were 5. Other States use rented aircraft. All but 4 States now use radio. This accounts for the reduced mileage of grounded telephone line. Similarly, permanent towers are replacing temporary lookout cabs.—DIVISION OF STATE AND PRIVATE FORESTRY, *Washington Office, U. S. Forest Service.*

DEVICE FOR TAKING WEIGHT FROM TANK TRUCK SPRINGS

Division of Fire Control
Region 6, U. S. Forest Service

The permanent spring sag which occurs in loaded tank trucks can be relieved by a novel and inexpensive device suggested by John C. Price, Jr., and George Norman of the Gifford Pinchot National Forest. Figures 1 and 2 give the essential details.

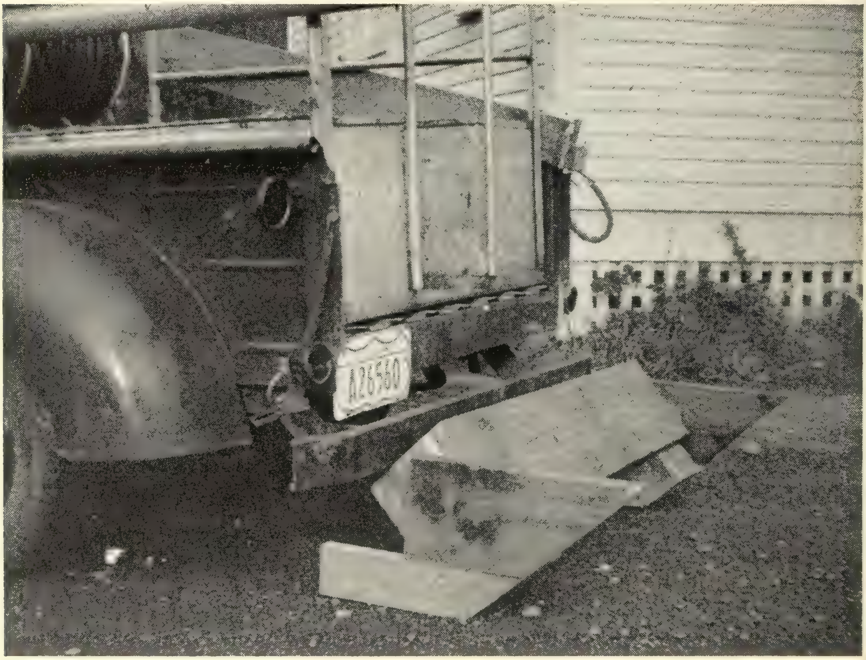

Figure 1.—Rear bumper in contact with blocks. At this stage an acceleration of the gasoline feed will back the truck up on the blocks.

The basic steps are:

1. Cut blocks so that when they are standing vertically they are the same length as the distance from the lower edge of the rear bumper to the ground *when the tanker is unloaded.*
2. *Fill* the tanker. Set blocks at such an angle that the top surface rests against the lower edge of the bumper.
3. Nail 2x6's in place with the blocks at this angle.
4. Join blocks at proper distance (wheel to wheel) by 2x12.
5. To prevent backing over the blocks, attach additional pieces as shown.

The device has several advantages. It takes 3 to 4 inches vertical-load pressure off the springs. No jacks or blocks are needed to accomplish this purpose, and no one needs to hold the blocks. It is portable, and

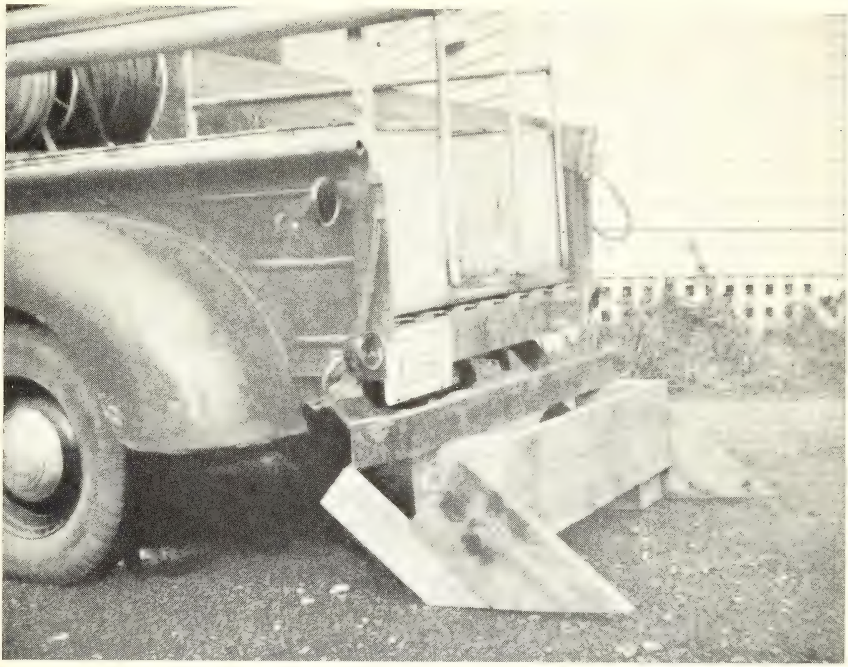

FIGURE 2.—Considerable weight is taken off the springs, tending to prevent permanent spring sag. There is still sufficient traction for the truck to be driven off the blocks.

can be used inside garages or outside in the service yard. The tank truck can be driven off the device with safety and no loss of time.

Sleeping Bag Roller

The cleaning and rolling of sleeping bags has always presented quite a problem in central fire cache equipment warehouses. When rolled by hand the bags are especially troublesome because no two men could roll them to a uniform size. In order to overcome this difficulty a bag rolling unit was designed and put into operation in the Forest Service warehouse at Spokane, Wash., in 1944. Besides rolling the bags to a uniform size, it has proved a great timesaver. We can now store six bags where we formerly stored four loosely hand-rolled ones.

The principles of this bag roller are the same as those reported on the Coski bed roller in the July 1946 Fire Control Notes. The device consists chiefly of a shaft turned by a crank-type handle and a movable platform which holds the bags tight against the shaft by means of springs.

The roller can be operated most efficiently by two men. One man places foot of bed about crank shaft. The other stands at foot of table and keeps bed straight and taut as it is rolled. If bed has no end flaps, the straps are tied before shaft is removed.

The newer type beds with end flaps must be rolled on the machine only until the flaps reach the roller. Flaps must be left free. The crank shaft is then removed and the roll is completed by hand. The flaps are tucked over each end, the head flap completed around the roll, the bed or tie straps tightened and tied around the bed, the flaps tucked in good and snug, and the end or puckering strings tightened and tied.

Detailed plans can be secured from the Regional Forester, Missoula, Mont.—L. E. NOEL, *Procurement Officer, Region 1, U. S. Forest Service.*

A SKYLINE FIRE EXTINGUISHER

A. B. Everts
Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

The use of CO_2 as a pressure medium for tank trucks and back-pack units has been previously reported in Fire Control Notes from time to time.

The old soda-and-acid booster tanks, used by municipal fire departments, have been pretty much replaced with CO_2 or by pressure provided by pumps. Most major fire-extinguisher manufacturers now offer water-type extinguishers pressurized with a CO_2 cartridge. Dry chemical, perhaps the most efficient of all extinguishers for certain types of fires, and even carbon tetrachloride and chloro-bromo-methane extinguishers can be purchased with CO_2 cartridges. More recently, one of the large manufacturers has developed a mine-car unit similar to the skyline fire extinguisher described here, except that the extinguishing agent is Karbaloy instead of water.

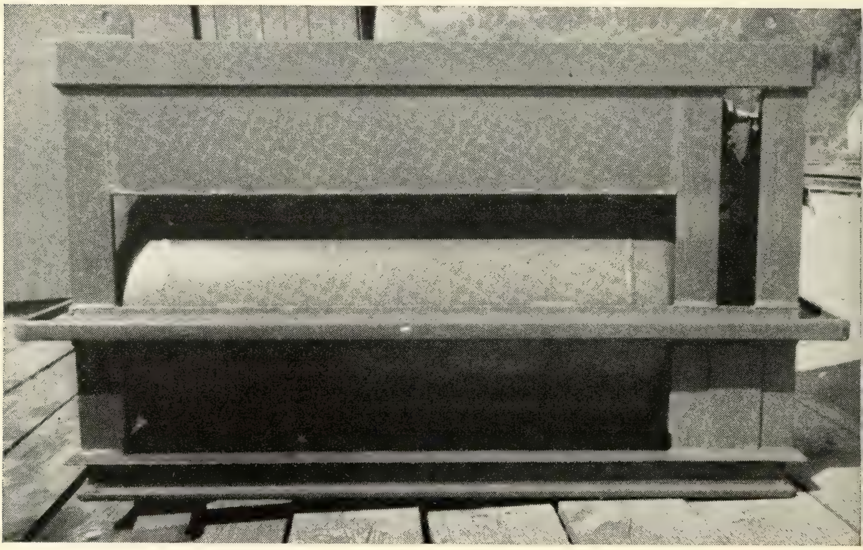

Figure 1.—Side view of the skyline fire extinguisher showing the hose and tool compartment on top. Heavily reinforced with railroad steel, it can absorb considerable abuse without damage. The tank is of 100-gallon capacity.

Two units of the skyline fire extinguisher were constructed by the White River Division of the Weyerhaeuser Timber Company of Enumclaw, Wash., several years ago. Each unit was constructed of heavy material (fig. 1). Weight was not an important factor as a skyline was used to transport the unit over the logging area. For use at log landings or as

slip-on units with speeders, logging trucks, or even tractor arches, they can be of much lighter construction.

Basically, the White River unit is a 100-gallon tank pressurized with a 15-pound CO_2 fire extinguisher of the squeeze-grip type. The inside tube must be removed from the extinguisher, otherwise the liquid CO_2 will freeze the control valve. With the tube removed, the gas instead of the liquid is withdrawn to furnish pressure.

The pressure regulator, which can be set at anywhere from 100 to 150 pounds' pressure depending on the safety factor of the tank, allows constant pressure; when the nozzle is shut off and pressure in the tank builds up to that set on the regulator, the flow of gas is automatically shut off.

A safety release should also be provided for the 100-gallon pressure tank, set to "pop off" at a few pounds over that for which the regulator is set. An inside tube, extending to the bottom of the 100-gallon tank and equipped with a shut-off valve, controls the water to the hose line. A 15-pound CO_2 extinguisher will discharge between 175 and 225 gallons of water (fig. 2). Thus, all the liquid in the tank is forced out of the nozzle since there is sufficient excess of gas to force the water through the hose line. This is not the case when pumps are used.

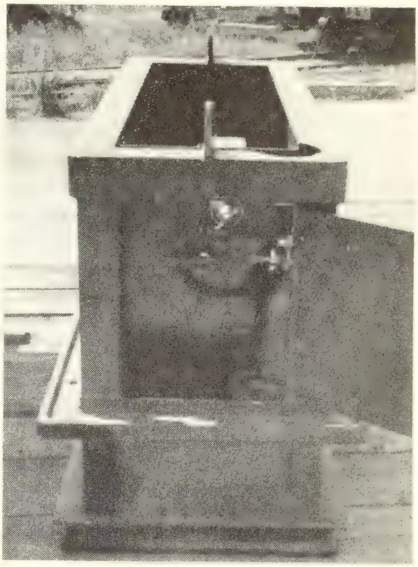

FIGURE 2.—End view with compartment door open. A 15-pound CO_2 extinguisher furnishes pressure for expelling the 100-gallon tank. Pressure is controlled and stepped down to the desired operating pressure by means of a pressure reduction valve.

In the White River unit foam is used. Six gallons of mechanical (liquid) foam is premixed with the water. A 150-gallon-per-minute foam nozzle with a shut-off is used on the end of 500 feet of 1-inch linen hose. This nozzle expends 15 gallons of water a minute, and the total 100-gallon foam-and-water premix will produce approximately 1,000 gallons of foam. In cases where linen hose has too much seepage, rubber-lined hose should be used. Two or three pulaskis and short-handled shovels are carried in the hose basket.

Wet water, in the place of foam, will work very well in a unit of this kind. The corrosive action of wet water on containers, which some of the wetting agents are said to produce, can be neutralized by the addition of 2 ounces of commercial potassium dichromate for each 100 gallons of treated water. This was reported by Robert S. McBride, California Forest and Range Experiment Station, in the April 1950 Fire Control Notes.

One new method of using wet water, in capsule form, makes it unnecessary to premix the wet-water solution in the tank. A "hydroblender" is installed outside the tank. The hydroblender will hold two capsules, each of which will produce 1,000 gallons of wet water. The untreated water is directed through the hydroblender only when wet water is desired.

Wet water is not cheap, and this new method of mixing the solution would seem to be worth further investigation.

CO_2 pressured units should never be considered for replacing pumps where large volumes of water are needed. The disadvantages are obvious. However, for certain fixed or even semiportable jobs and as extra protection in risk areas, they certainly have a place.

Except for freezing, in cold climates, they can sit for months, or even years, and be ready to operate by simply cracking the CO_2 valve and opening the hose-line valve. Antifreeze can be used in the water if desired. There is no engine to start or to maintain. There are no moving parts except in valves and pressure regulator. Foam, wet water, or Karbaloy can be used without injury to the equipment. An excess of CO_2 pressure makes it possible under certain circumstances to utilize all the water in the hose. Pressure remains constant throughout the operation until CO_2 supply is exhausted.

Tanker Use by the U. S. Forest Service, 1950

Tankers were used on 2,212 fires, or 22 percent of all fires controlled by the Forest Service, in 1950. The California Region led all the others by putting tankers on 973 fires. Tankers were employed in the initial stages of attack on 1,131 fires and assured control of 70 percent of these. On 646 fires tankers were sent in for mop up only. Tankers and pumpers are credited with holding 142 miles of fire line.

Aircraft Use by the U. S. Forest Service, 1950

Some 5,636 flights totaling 8,248 hours were made by fixed-wing aircraft in 1950 on fire control work on the national forests. The 16 airplanes owned by the U. S. Forest Service made 41 percent of the flights, contract operators accounted for 58 percent, and military aircraft 1 percent. Helicopters were used in California for 1,255 hours out of a total of 1,381 hours of flight. Aircraft transported 10,244 passengers and 377 tons of supplies, of which about 174 tons were dropped by parachute. The California Region made the greatest use of aircraft during 1950 while the Northern Rocky Mountain Region ranked second.

Volume 12 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

PLANNING HELIPORT SITES

Cal Ferris

Chief Pilot, Region 5, U. S. Forest Service

Contemporary forest administrators have experienced an entire decade wherein the principles, practicability, and economy of almost limitless movement over the earth's surface via helicopter have been demonstrated and developed. Therefore, the wishful thinking and general plans of the past must now be reexamined in the interests of future developments in forest transportation.

Conception of the helicopter phases for project or fire planning can be relatively simple if the proper use is made of available data. This data concerns helicopter performance and operation in combination with the established factors of load, ceiling, range, ground speeds, costs, and flight imitations.

EQUIPMENT CHARACTERISTICS

When considering the performance of aircraft it is important to remember that the weight-sustaining capacity of air varies significantly with barometric pressure and temperature. This capacity decreases with an increase in either temperature or elevation. Therefore, the weight-sustaining capacity of the air at flight terminals is of vital importance in problems involving the landing of men and supplies. Once under way a helicopter can safely carry loads at altitudes under atmospheric density conditions in which it would be impossible to take off, hover, or land. Therefore, planners of heliports should have at hand guides for calculating these effects on standard helicopter performance. The Forest Service will include this essential information in an Aerial Operations Handbook it is preparing.

It appears now that helicopter designs suitable for use by the Forest Service will be standardized along the line of the Bell, Hiller, and Sikorski models. These models all have a single main horizontal rotor of two or three blades with a small vertical two-bladed, antitorque tail rotor. Maximum dimensions of these types are length, 40 to 60 feet; span, 30 to 50 feet; height, 8 to 12 feet; maximum gross weights, 2,500 to 6,000 pounds. The choice of landing gear installations is optional and includes skids, floats, or tricycle and quadruped wheel installations. Average pay loads vary from 400 to 1,600 pounds. Cruising ground speeds are approximately 50 miles an hour, block to block. Useful range is about 2 hours' flying time. Useable ceiling is around 9,500 feet. Operating cost runs from 40 to $160 an hour for integral equipment and $60 to $225 for contract and chartered helicopters and crews.

PLANNING CONCEPTS

Most planned transportation systems include access roads and trails which are added primarily for fire, project, or some other one-shot purpose. Such plans should be critically examined to determine whether these roads and trails can be eliminated and aerial methods of coverage substituted. Also, a skillfully managed over-all helicopter operation would obviate the necessity for maintaining many existing roads and trails. Obviously, savings would result in both construction and maintenance costs.

It should be remembered that helicopter planning encompasses area or radial coverage in contrast to the strip type of coverage usually provided for; this may result in a certain amount of allowable overlap in controlled area.

The heliport plan should provide for three basic site classes, permanent, semipermanent, and opportune. These are summarized in the following tabulation and shown in figure 1.

Class	*Development*	*Name*	*Designation* [1]	*Facilities provided*
I	Permanent	Base heliport	BLIP (◈)	Maintenance, servicing, communications, housing, parking, air markers and navigation aids, safety devices.
II	Semipermanent	Satellite heliport	SHEL (O)	Maintenance, servicing, communication.
III	Opportune	Helispot	HIPO (X)	Only as needed.

A fourth site class, undesignated emergency spots (EMOT), covers a large number of locations that are developed and used to accommodate some special demand for helicopter service. Although records of these sites should be carefully maintained, such sites need not be considered under any but the most intensive type of transportation plans.

Mapped locations (fig. 1) should be further described in accompanying notes to include essential information. An example follows:

BLIP #1 System

Identification	*Location*	*Elevation*	*Description*	*Remarks*
SHEL-B	Dome Rock	4200′	Raised rock dias at peak. Wind sock 50′ E.	10% slope E. Critical temp. 48° F. 1 drum, 80 oct.
HIPO-3	Blue Lake	3750′	Marked by buoy in S cove—40′ from beach.	Floats only 3′ water (4-2-51 F)

Correction sheets are necessary to keep the records accurate between regular revisions.

AREA PLANNING

For the present, helicopter facilities should be planned primarily for all areas below 7,000 feet elevation which are inadequately served by other existing or planned transportation. Those areas deemed especially suitable for development should be outlined on a standard scale topo-

[1] The system of phonetic identification serves to minimize confusion in identifying specific locations. For example, "As soon as the dozers are finished at SHEL-Dog, send one to help the crew on the job at Charlie-HIPO-five."

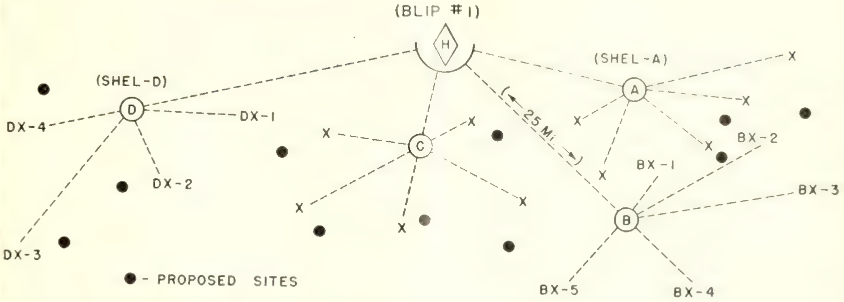

FIGURE 1.—Schematic diagram of proposed sites in a heliport plan. Blip (◈), permanent base heliport; Shel (O), semipermanent satellite heliport; Hipo (X), opportune helispot. (Phonetic identification clockwise.)

graphic map. In this planning, ground control areas should be examined for the possible elimination of nonessential roads and trails. Only very special sites, such as airports or flight strips, large lakes, or meadows should be considered for elevations above 7,000 feet.

Altitude zoning can be accomplished through the simple expedient of coloring all areas red on the base map above 7,000 feet and hence unsuitable. The zone between 4,500 and 7,000 feet, which is considered suitable for marginal or reduced services, can be cross-hatched or a cautionary color, such as yellow, used.

Another very essential part of the base map is the precise location of air hazards such as power and telephone lines, spans, and trestles, and known ground hazards, such as fences, wet or gullied meadows, hidden slash, stumps or rock outcrops, crusted areas, and submerged hazards.

Designated heliport sites can be indicated on the base map, but are preferably shown on a transparent overlay that permits easier revision, reproduction, and interpretation.

The over-all spacing of site locations varies according to individual situations, and is discussed later in detail.

Consideration of site suitability with regard to accessibility should be considered next by the planners. This entails a careful study of factors such as adjacent obstructions, wind currents and other hazards, and site surfaces; and evaluation of use patterns including concentration of users, available transportation facilities, such as roads, trails, airports, waterways and lakes, and values to be protected or managed.

GENERAL CONSIDERATIONS FOR SITE LOCATION

If possible, place the heliports above the areas they will serve and where they can be quickly and easily reached by complementary ground travel. Because a very real hazard to personnel is always present in the moving rotors, every possible precaution must be taken to minimize this potential danger. This includes placing marshalling areas for any significant assemblage of personnel, stock, or equipment at least one-tenth of a mile away from the spot; providing for ground access routes well below the plane of all rotors and from directions easily visible from the control station in the machines; safeguarding against injuries to eyes and lungs, which can be

caused by dust blown from untreated surfaces by rotor blasts. Operating areas should be fireproofed to protect valuable equipment, and in addition, portable extinguishers should be provided to the necessary servicing facilities.

It has been suggested that three categories be established for determining the priority of heliport development, viz., (1) earliest possible, (2) probable future, (3) upon special demand. Where proposed sites are questionable for any reason, a general helicopter pilot or his technical equivalent should be consulted before final approval for development is granted.

PERMANENT AND SEMIPERMANENT HELIPORT STANDARDS

In selecting a heliport site, consideration should be given to (1) the type of service expected; (2) number and kinds of helicopters anticipated; (3) clear channels of approach; (4) surrounding obstructions and their effect on air currents; (5) surface conditions.

With present equipment, a heliport should have approaches to permit landings and take-offs at angles from the outer limits of the touch-down pad of 10:1 into the prevailing wind directions and 5:1 in other directions. These minimum angles will permit safe and economical operations under all conditions.

The touch-down pad should have a minimum diameter of 50 feet where not more than one helicopter is to land at a time. The safety area that surrounds the pad will vary depending upon obstructions and dust conditions. This area should extend a minimum of 50 feet from the outer edge of the touch-down pad, be restricted by a low barrier, and it should be dust and fire proofed. Above 6,000 feet this site must have a very smooth, extended surface to facilitate running take-off techniques. The sharpest possible contrast between the pad and the safety zone should be obtained for easy air identification under all conditions. When this is not feasible, the heliport may be marked by a circle with an "H" in the center. Where night operations are anticipated, a distinctive flashing beacon, boundary, wind indicator, and obstruction lights should be provided.

Roof, platform, or other structural heliports must be stressed to withstand impact load strains equivalent to $\frac{3}{4} \times$ the gross weight of the helicopter on any one square foot of surface, in addition to existing dead loads.

Easily visible wind-direction and velocity indicators, either small socks or flags, should be provided for all heliports.

A diagram for heliport site improvement is shown in figure 2. The requirements illustrated are for normal conditions. Allowances to compensate for any variance will be necessary.

TEMPORARY LOCATIONS AND STANDARDS

Helispots are ordinarily located at opportune sites that require a minimum of improvement for their occasional use. These spots should be prospected and charted in anticipation of convenient development. No maintenance is normally contemplated. When one is improved, the records of its characteristics and use should be kept for future reference.

Open ridges with opportunity for horizontal or descending take-off in either of two prevailing wind directions represent suitable sites. These sites

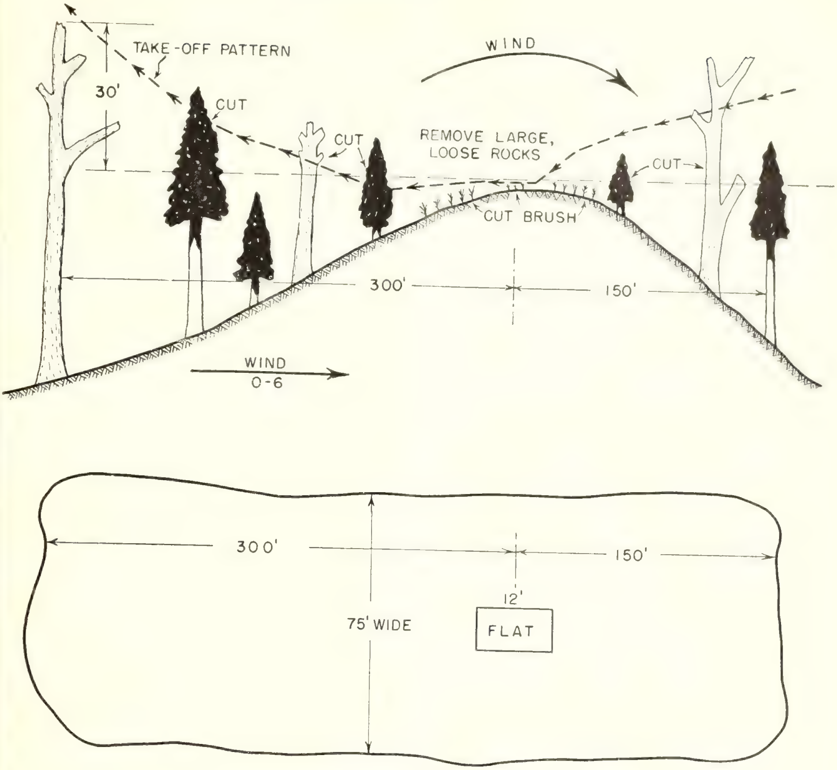

Figure 2.—Heliport site improvement plan.

must be free of brush, trees, or other obstructions protruding above the level of the touch-down pad.

On sharp ridge tops below 6,000 feet where brush and trees are not a problem, a nearly level spot surface about 10 by 15 feet is normally adequate for one-ship operation. On areas where low brush or trees are not more than 10 feet tall, the cleared landing spot below 4,500 feet should be at least 60 feet in diameter. Where obstructions or elevations are higher, the diameter of the cleared area must be increased to conform with the appropriate translational lift and rate of climb tables.

No landing spot should be considered in the plan that has more than 10-percent surface slope. Emergency landings can be made on steeper slopes, but such slopes are in the "critical landing" class and have no place in a preplanned system.

A smooth, flat surface is not essential to a landing spot if the pilot is fully aware of what he is settling down on. Emergency operations are frequently conducted from boulder strewn, gravel washes and sand bars. The key is to insure that no rocks or stumps stand high enough to touch the supporting structures of the alighting gear. Special care should be taken to guard against soft or crusty spots in the touch-down surfaces. Brush stubs and rock piles must be leveled to reduce skid rocking, tire and float puncture, or snagging of occupants.

If a landing spot is on a sharp knob or a ridge, the ground effect will be lost very soon after take-off. In all probability this will occur while the helicopter is undergoing the critical transition between hovering flight on a column of compressed air and translational flight which derives lift from relative motion through the air. To compensate for this, the area in front of the landing spot should be cleared a bit lower than the site level for at least 100 feet from pad boundaries along the departure routes.

Brush, tall grass, or other protruding obstructions must be cleared out from approach zones so that the tail rotor (clearance less than 3½ feet) will not hit anything during the flare-out for landing. Care should also be exercised to avoid pockets, saddles, bluffs, and other spots which are normally subject to unforecastable bad air currents.

PLANNING THE LOCATION OF LANDING SPOTS

Planning for the spacing of site locations consists largely of applying old, established principles and logic in such a way as to exploit the unique advantages of the helicopter. In addition to the general factors discussed earlier, there are a few basic systems used for planning heliport networks. These systems vary because they are designed to fit individual situations.

The first and most widely accepted system is employed in the California Region. This region's primary objective is to achieve hour-control over areas where existing and planned transportation facilities are deemed inadequate. The question of adequate hour-control coverage is determined by a careful study of all implications involved in the various combinations of flammability types—values that could be affected through a changeable use pattern. The risks and hazards resulting from a changeable use pattern must also be considered. This system lends itself very well to the adjustments required where lower priority control zones, i.e., lesser values and/or occurrence, are encountered. Theoretically, in areas where characteristics are uniform, this system results in locating heliports in places equivalent to approximately twice their allowable attack radius.

Similarly, some other controlling factor in heliport placement, such as normal rates of spread, will serve. When the least favorable circumstances are selected as a controlling factor, the number of bases should be held to a minimum by strategic adjustments suited to the various flammability zones. As an example of this system, in a 30-minute zone, the bases might be spaced about 40 to 50 miles (1 hour) apart. This would mean that even peripheral deliveries from adjacent bases to spots nearest a fire could be accomplished in 20 minutes and so allow sufficient time for ground travel. Where innumerable chances exist for the use of smoke-hopping techniques, the location of bases at radial extremities near 25 miles might be possible.

Secondary satellite bases can be spaced inversely proportional to rates of spread. This will result in a greater number of bases in brush than in timbered country. Cover types, topography, values, benefits, and costs are given increasing weights in considering these developments. Such landing spots should be planned so that they are strategically interspersed and complement the more permanent facilities. Frequently these spots are located only to accommodate some specialized function, such as critical points along a fire line, rescues and evacuation of personnel, or as the result of emergency landings.

Another basic system for planning and selecting heliport locations is becoming increasingly popular and successful in highly developed parts of the western regions. This system is planned by geographical drainage or value units, and is especially applicable to areas where moderately intensive transport, management, and protection already exist. It employs the same fundamental plans of location and construction already discussed.

Intimate field knowledge of all the aspects of the terrain involved, along with the real nature and value of the associated resources, is prerequisite for selecting this system. When considered for, or applied to, relatively undeveloped areas, the additional planning investigations necessary to assemble the required data are expensive, time consuming, and often prohibitive.

Such a system frequently requires greater liaison between districts and forests to provide for joint controls and development of boundary areas. In aerial operations, the importance of artificial boundaries is secondary. In other words, under this drainage system, don't terminate plans along a stream that separates two units when desirable landing spots are available on the other side.

An additional factor in strategic placement under this system is to locate Class I and II heliports at easily accessible spots along the major divides. This will make it possible for the helicopters to drop off into the various areas with the least delay and greatest ease.

For areas that approach the ultimate intensity of planned coverage, special heliport systems can be devised wherein the fullest possible use is made of pertinent data already assembled. Examples of this type of planning may be found in areas undergoing development similar to the upstream flood control established for the Los Angeles River drainages. This project combined the acme of present planning concepts, based on intensive evaluation studies, with an intimate knowledge of fire occurrence and behavior.

As a result of the careful correlation of all factors, both real and implied, local fire protection authorities were able to complete their collective protection strategy and actually pre-locate fire lines which are now being developed as fast as possible. Helispots are located wherever necessary to fill in transportation time gaps and provide economical services. Such planning has made possible the simultaneous construction of improved helispot facilities at frequent intervals along actual fire lines which, fortunately for this purpose, follow the ridges in flash-fuel cover types. Since both the crews and equipment are "on location" for this special type of associated construction, helispot construction and improvement costs are advantageously reduced to an absolute minimum. As an example, Angeles National Forest reports average helispot construction costs in medium brush at $12 for hand labor and $9 for tractor. A complete discussion of the development of this system appeared in FIRE CONTROL NOTES, April 1951.

In addition to the essential preparations of basic data already described, the following actions should be employed wherever necessary to insure the easiest evolution of the complete plan.

1. Make a vellum overlay for each sheet of the planned road system status map, with match marks and other data necessary for its accurate use over the base maps.

2. Consider the possible elimination of questionable corollary projects at this stage, and include any actions shown in the current record correction notes.

3. Show on the transparent overlay new roads, airstrips, artificial lakes, or any other especially suitable facilities not included on the base maps, excluding field headquarters, commercial heliports, military installations, etc.

4. Show on the overlay locations temporarily selected as suitable. These selections can be based on personal knowledge and consultation, careful study of topographic maps, or interpretation of aerial photographs.

5. Shift proposed locations to improve the pattern. The center of a movable transparent disk, with the radius determined by control factors, can be shifted among the proposed site locations for a rough illustration of theoretical time-zone coverage limits.

6. Reexamine the preliminary proposals, fill in the gaps, reduce congestion and overlap. An acceptable academic coverage pattern should result.

7. Number 6 is an office phase of the planning and must be substantiated by objective field investigations of proposed sites. To accomplish the job of field checking all proposed sites solely by ground reconnaissance is impractical. A combined air-ground check will cover hundreds of sites in a short time, and information obtained by reliable air observers will be accurate enough to pin point most of the suitable spots and coordinate the proper interim development of other facilities. Checkers should be especially alert for unfavorable flying conditions such as down drafts, obstructions, and congested areas. Avoid spots that would involve difficult engineering projects, such as rock outcrops, and marshes, whenever possible.

8. As a result of the above actions, select, within allowable economic limits, the locations that are best suited to the standard of development proposed. Eliminate the unsuitable ones and readjust the pattern to fill any gaps.

9. Educate field personnel in the intricacies of recognizing low-standard sities and alert them to the necessity for studying their local areas for sites requiring minimum development. They should also be taught to note possible locations and forward pertinent records to the appropriate engineer.

As the heliports are developed or altered, they should be classified and identified for reliable reference; accurate maps of the locations and historical records of their prior uses should also be maintained. This is essential information for the local engineers and air officers. It may be desirable in some locales to planimeter the helicopter zones and determine such factors as the facility-square mile ratios, by zones, etc.

Improving Teamwork on Interagency Forest Fires

The suppression of many forest and range fires requires joint action by personnel of two or more protection agencies. To be most effective good teamwork and mutual understanding must be developed in advance. The usual formal written cooperative fire control agreements between agencies should be supplemented by local working arrangements. It is important that variations in policies, procedure, organization, and terminology be understood and reconciled in advance if delays and misunderstandings are to be avoided.

In order to study these problems and attempt to improve future joint suppression action, a very successful meeting was held in Yosemite National Park on April 19

and 20, 1951, attended by more than 60 Forest Service, National Park Service, and California State Division of Forestry officers. These men represented the Regional Offices and State Forester's Office, 3 National Forests, 4 National Park areas and 5 counties.

Each agency analyzed its fire and administrative organizational setup, procedures, fire overhead job descriptions, and terminology. Minor variations were noted but no serious obstacles to joint action were apparent so long as these differences were known in advance. Following this discussion the group divided into 4 teams, each composed of representatives from the several units of the three agencies. A sample large fire problem was worked out for manning, tactics, strategy, and supply. Each team solved the problem independently and, when later compared, all solutions were similar despite the diversity of organization and variation in general agency objectives and programs. In fire control all strive for the same result—reduction of losses.

Selection and designation of overhead positions on joint action fires was discussed in some detail. The accepted rule that one man must be given total command as fire boss on every fire was recognized. It was also agreed that the best man, regardless of official title or agency, should be selected and that this is the responsibility of top local administrators who should have an advance understanding in this regard. After a fire boss is designated it is his responsibility to make systematic division of work on the fire to utilize all men and facilities of all agencies to best advantage. Individual and agency responsibilities and their tie-in to the over-all plan must be clearly defined. A fluid and dynamic organization must be established and maintained. Many of these matters can be prepared for in advance by mutual discussions such as this meeting provided.

Perhaps the most difficult problem of fire suppression involving overhead from more than one agency is that the men may not know each other well. A fire boss must have confidence in his key assistants and they in turn must rely on his competence and judgment. Without this mutual reliance weaknesses develop in management of the fire. If no other value had been derived from this meeting of the three agencies, the fact that each man became acquainted with the others made the meeting worth while. Official titles and other formalities were promptly forgotten. From this acquaintance mutual confidence and understanding should be immeasurably increased.

The group recommended the holding of similar meetings annually. Others might benefit from this type of get-together.—L. F. Cook, *Assistant Chief Forester, National Park Service.*

FIRE PREVENTION NOTICES IN VIRGINIA

George Dean

State Forester, Virginia Forest Service

The posting of fire prevention notices along the highways has long been a standard public relations technique here in Virginia. During World War II a few roadside billboards were carrying forest fire prevention messages, but it was not until 1947 that more intense efforts of this kind were directed at the motoring public (fig. 1).

Metal highway signs, of which there are 5,600, are erected on all the primary and all paved secondary roads in the State. These signs, made of 16-gage steel, measure 24 by 30 inches, and have raised green lettering on white baked-on enamel background. The signs were made by the metal shop of the State penitentiary at an approximate cost to the Virginia Forest Service of $2.30 each. The signs are mounted on 4x4-inch pine posts ob-

Figure 1.—Fire prevention notices in use in Virginia.

tained from and creosoted at the Buckingham State Forest. The coverage obtained from 5,600 signs is approximately 1 sign every 7 miles.

The next move to attract the attention of the motoring public was to make a unit of the fire warden tool box and warden flag and locate them conspicuously along the highway. A large metal sign, stating the fire fighting tools in the box are for use on forest fires, is mounted on the front of the tool box facing the highway. The warden's name is lettered on a paddle which is hung under the warden flag. This complete warden unit naturally causes local comment and also augments State-wide forest protection publicity.

All Virginia car owners are required to purchase license plates annually. Inserted between the new license plates he now finds a reminder on forest fire prevention. The appeal usually is directed to the use of the ash tray in the vehicle. This license stuffer reaches approximately 800,000 vehicle owners each year.

The Virginia Department of Highways has been developing picnic areas along all the major highways. There are now 1,243 such sites. At each of these areas the Virginia Forest Service has erected a poster board, made of wood, on which an outdoor fire prevention poster is tacked.

There are also, especially in the mountain section, developed vistas. Here, too, posting boards are erected. Truck pull-offs, usually at the top of a long grade, are excellent spots for these poster displays.

License plate attachments, made of light metal cut in the shape of the State and carrying the wording "KEEP VIRGINIA GREEN" on a forest green background, have been requested by a large number of people. Approximately 6,000 of these were given to vehicle owners by the Virginia Forest Service last year.

Large wooden, creosote-colored fire prevention signs, with routed 6-inch letters painted orange, have been erected on all the main highways leading into the State. These signs are very rustic in appearance, measure 8 by 3 feet, and are hung with large logging chain between 10-inch chestnut posts.

Smokers are responsible for approximately 38 percent of the forest fires in Virginia each year and it is believed that a good prevention program directed at the traveling public will probably reach most of the smokers. It is only through the splendid cooperation of the Virginia Department of Highways that this entire program has been possible.

Protection of Fire Tool Handles

To protect handles of fire tools carried in pickups and tanker tool boxes cut lengths of old cotton fire hose 1½ by 42 inches and slip them over the handles. This practice adopted on the Happy Camp District has lessened the problem of tool maintenance.—Gideon S. Parker, *Modoc National Forest.*

MACHINES AND THEORIES

Frank J. Jefferson

Assistant Regional Forester, Region 5, U. S. Forest Service

We have available to the field of fire control today several relatively new machines. Our constructive thinking is lagging, however, as to which of these truly offer increased strength to fire control and how they can be used most beneficially. We are inclined to accept theories as facts and, because of this, apply them in an amateurish, unresultful way. We shy from going through the hard process of working out in detail the changes in organizational practices necessary to make these new machines of fullest use, and of evaluating the cost-benefit ratio. The pitfalls inherent in such a casual method do not show up much during an "easy" fire season, but they certainly raise hob with fire control effort when the chips are down and every move must be made with dispatch and sureness. For the purpose of this discussion, let's consider four items that have been much in the limelight in recent years. There are others.

HELICOPTER

The helicopter obviously can give all fire-fighting overhead, including fire boss, division boss, and sector boss, up-to-date information in a matter of minutes as to conditions on all parts of a fire line—even on a fire of 40-mile circumference, 40 miles in 40 minutes. A fire boss can get a quick picture of the entire situation; and remember he sees all of this himself, and can personally evaluate all observed situations as they relate to each other. Compare this with ground practices where scouts laboriously work over segments of line, send in their data by radio, telephone, or messenger. The fire boss and his assistants must then plan actions based on interpretation of information which in many cases is several hours old.

Well-coordinated use of helicopter and radio can reduce the force behind the line and improve surety and timeliness of action. The helicopter can provide quick transport of workers from one critical point to another, and the number of points where it can be landed on a fire line, if the pilot is skilled, is truly surprising. This machine can also make quick deliveries of water, tools, food, and other essential supplies to line workers by either landing or dropping, and men can be maintained close to their job if camp bases are properly selected.

To accomplish all of these things, however, in a degree that pays off in reduced cost and losses requires an operation planned and acted upon at the helicopter's speed level rather than one part at the helicopter's level and the other at truck speed. For example, last summer thirty-odd men were picked up one afternoon on a section of line, transported by helicopter several miles to a new sector, and sent into action immediately. Later in the afternoon a new camp was established by helicopter on that sector. Not until night came was it realized that the personal belongings, time slips,

and other important items had not been shipped to the new base. There were two results: a near riot on the part of the crew, whose first thought was no clothes, no pay, no nothing; and poor crew work and morale the next morning. All of this resulted from an incomplete helicopter-use plan.

In planning, it must be remembered that the possibility of any sort of air operation is controlled by visibility and air condition. Smoke, fog, darkness, or excessive wind rule out the air. So whatever the plan for air use is, it must be complemented by an alternate plan based on the old reliables of transport by truck, by tractor or by mule, and as a last resort, by man back-pack, if sureness of action is to follow. But first of all, if we are going to use helicopters, we must get thinking and actual planning fully attuned to the speed with which a helicopter can act. This requires methodical planning of the ways and means of running a helicopter operation and a methodical carrying out of the plan. The plan can't be "catch as catch can"; it must be completely fitted to the machine that it uses, or it will not pay off.

RADIO

What has been said about helicopter can well be applied to radio. This device can be one of the most helpful that we have for speeding up all phases of line action. It is a worthy complement to the helicopter, and together they can revolutionize the first suppression job. However, radio can likewise excessively complicate an undertaking by its very speed of action. The failure of a fire boss and others who give instruction by radio to promptly send instructions to *all* who are concerned with the action of an individual, or results of the action, may have serious consequences. Here again there is urgent need to figure out the essential procedures necessary to fit the speed of radio action and then sternly discipline ourselves to observe these procedures.

TRACTORS

We must learn to use tractors as a complement to man-power and not regard them as a complete substitute therefore. Tractors can build line but have never yet clean-burned one. They never will. Probably the greatest cause of line loss today is from unclean tractor lines. A few flights over major fires should convince anyone of this. The miles of lost tractor line are appalling. Here again is a device that can be a mighty ally. Its usefulness, however, is being negated because men, fascinated by its brute strength, noise, and ability to produce wide line quickly, are disregarding the basic principle that a safe fire line is a clean-burned one.

BOMBING PLANES AND OTHER AERIAL OPERATIONS

It is theoretically possible to put water on fires in practically unlimited quantities from the air. All that is needed is a sufficiently large fleet of planes equipped with big water bombs and a landing place with water supply close to the fire. Practicably, this means that the Nation would have to be covered by several thousand water-equipped bases, each with probably [illegible]0 large bombing planes and trained personnel available, to make the operation effective. The cost of such an undertaking would be staggering;

it would still be staggering if such operations were limited to the west coast. Therefore, this is one of the proposals that, while theoretically possible, is unsound economically.

In the author's opinion, rain-making projects are likewise economically unsound as a generally planned-for fire control measure. Granted that under proper atmospheric conditions, and with proper equipment, rain can be made. However, it just isn't ever going to be possible, at a reasonable cost, to insure having the proper equipment and materials available at the proper time and place. And no man can arrange to have the proper type of cloud on hand at the time of a fire. In this connection, it is important to realize that while a day or so's difference in time isn't too vital in the case of rain for crop production, it is a tremendously important factor in fire suppression. In that day, fire is over the ridge and far away. So again we have a theoretical possibility that in application is limited.

There is loose thinking concerning the use of planes for observation purposes. All too many believe that the availability of a plane is the key factor. This belief is definitely wrong. A plane is necessary, of course, and it must be a plane that is *safe* for the proposed operation. The controlling factors from the fire-information standpoint, however, are the availability of pilots with the skill to safely put a plane in the right place for the observer's purpose, and observers with skill in the knowledge of fire behavior and the ability to interpret and accurately record fire facts that they see on the ground. These qualifications are infrequently combined in a pilot, and all too often casually assigned observers can't interpret or correctly record what they see. The result is misinformation and erroneous-action decisions.

Our use of the plane or helicopter for observation purposes will not be most productive until we develop an adequate corps of skilled pilots and properly qualified observers for each unit of organization, i.e., forest, county, or association area. This does not at all mean pilots and observers who are regularly on a fire control agency payroll. Many private pilots and their fellow workers can be trained in this field if adequate effort is made. Identification and interpretation of fire facts is not an esoteric art.

THE FLANNELGRAPH AS A FIRE CONTROL TRAINING AID

Robert B. Moore

Forester, Region 4, National Park Service

Fire control training officers search constantly for new methods or media to increase the effectiveness of fire control training. During a recent meeting devoted primarily to a review of the principles of fire management and the build-up of organization on large fires the flannelgraph proved to be an arresting and effective training aid.

The flannelgraph works on the principle that some materials have an affinity for each other. Flannel, felt, or sandpaper will stick to a background of flannel without an adhering agent even when the background is in a vertical position.

Flannelgraphs have many uses. They are at their best, however, as lecture aids, especially when used to show changes, tell progressive stories, or make comparisons.

Our flannelgraph story used the organization chart for large fire suppression from "Principles of Organizing For Forest Fire Suppression," California Region, U. S. Forest Service. Primary and subordinate functions for the respective fire positions were briefed and printed in large block letters on colored, medium-weight paper. One color was used for the top fire Management functions, another for Suppression, a third for Planning, and a fourth for Service functions. Job titles were printed on plain white paper.

Pieces of flannel were rubber-cemented on the backs of these separate "parts." A 3-foot-square piece of good grade white cotton outing flannel was used for background. The background flannel was stretched tautly and fastened securely to a smooth wall.

By adding, shifting or removing the parts as desired the training officer is able to present clearly and simply the progressive build-up of organization from a small one-man or one-crew fire to the more complex large fire organization. Uniform and clear-cut distribution of duties and definite channels of command can be emphasized graphically as the story unfolds. Functions that must be performed on every fire, regardless of its size, manpower and equipment requirements, can be effectively presented.

The flannel-backed parts sometimes require a slight hand pressure to adhere well to the background. Fine to medium grained sandpaper is said to work best of all as backing material.

The flannelgraph should be kept as simple as possible. Illustrations or lettering should be big and bold to be easily seen from a distance. Colors stand out. The flannelgraph should be well lighted. For the leader's convenience the parts should be numbered or otherwise identified or arranged for orderly use. Guide lines may be required on the background.

Admittedly we have but scratched the surface in the use and adaptability of the flannelgraph. We found it to be a most effective aid deserving of wider use in forest fire control training.

EASELS FOR FIELD USE

J. W. Mattsson

Forester, Fire Control, Region 4, U. S. Forest Service

Frequently we use easels in connection with field fire training. Regular blank newsprint is the material upon which we outline training plans, summarize discussions, etc. Also in our training, including safety training,

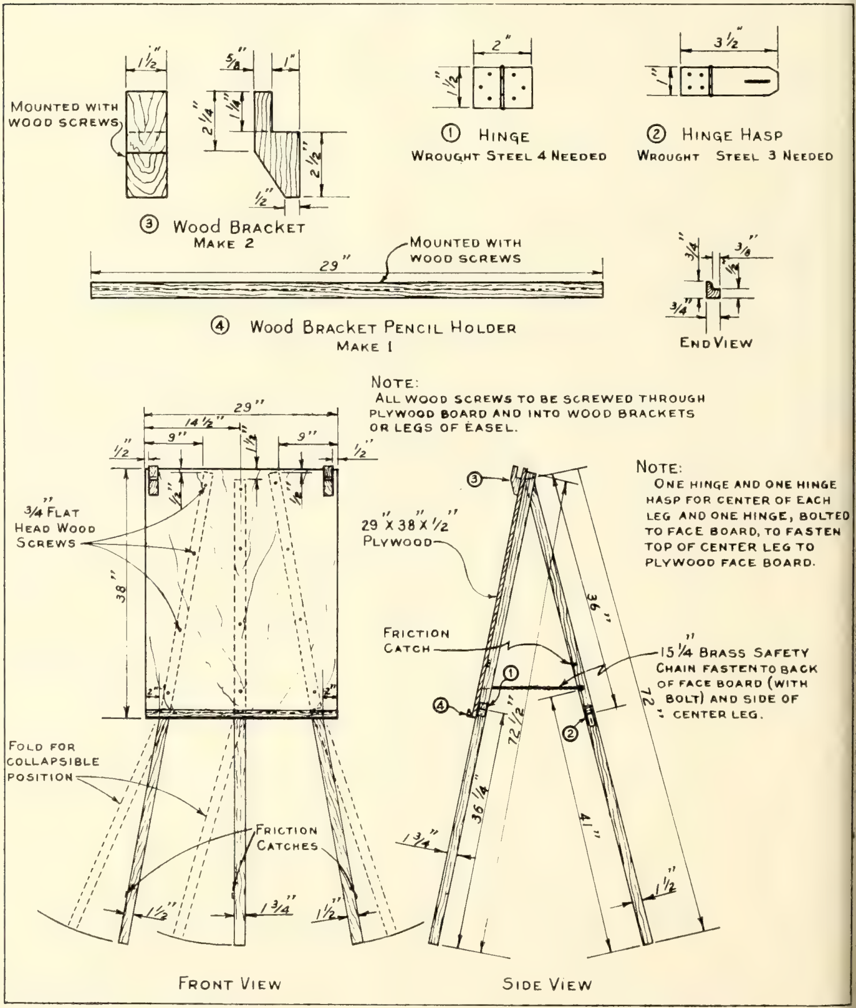

Figure 1.—Portable field easel.

of project personnel we have used easels right on the jobs. The easels available have usually been heavy, cumbersome structures that were hard to carry, especially when the training sites were some distance off roads.

In order to get an easel that was easy to carry, light and compact, yet rigid enough for field use, we designed one using 3-ply plywood as the backboard (fig. 1). The legs were made of 2x2-inch pine hinged where they extend away from the plyboard so they fold up to make a compact unit for transporting. Ordinary 1½-inch hinges were used on one side of the break in the 2x2-inch material with 3½-inch hasps on the reverse side. By setting the hasps so they fit very tightly no additional reinforcements of the legs are necessary. Friction catches hold the legs in place when folded back. A strip of molding serves as a pencil and chalk rail.

The materials necessary to construct such an easel are:

- 1 piece plywood, 29 by 38 inches
- 18¼ linear feet, 2x2-inch pine
- 1 piece molding, 29 inches
- 2 wood brackets
- screws
- 3 hasps, 3½-inch
- 4 hinges, 1½-inch
- 3 friction catches
- 1 piece chain

This Region has a number of such easels in use and they are proving mighty convenient. They cost about $10 each to construct, including labor. The approximate weight is 19 pounds.

Copies of the diagram are available from U. S. Forest Service, Ogden, Utah.

Published Material of Interest to Fire Control Men

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COOPERATIVE FOREST FIRE CONTROL IN PENNSYLVANIA

C. L. Kinney, *Resource Management Staff Assistant, Allegheny National Forest,* and A. H. Vogler, *District Forester, Pennsylvania Department of Forests and Waters*

Pennsylvania was one of the first States to provide a State-wide system of fire protection for all its land. Under an act of its General Assembly in 1915 a fire control organization was assembled and trained, and since then it has expanded and improved until today it is one of the best in the country.

This organization is directed by the Chief Fire Warden in the Bureau of Forests, Department of Forests and Waters, at the State Capitol in Harrisburg. Line of authority is from Chief Forest Fire Warden to the State regional foresters (five in number) and thence to the man on the ground, the district forester. By State law the district forester is responsible for forest fire control on *all* land within his district whether it be delinquent land, game land, private estate, or national forest. He has a complete fire control organization: lookouts, inspectors (guards), wardens, cooperators, dispatcher, with the necessary tools and equipment.

Allegheny National Forest was established in 1923. Although the three quarters of a million acres of land within the new national forest was already protected from fire under the State law, it was agreed early that the United States Forest Service would be responsible for fire control. The reason was twofold: The Forest Service would thereby assume a fair share of the costs, and members of its staff would become familiar with the over-all fire control work.

The result was a hybrid Forest Service fire control organization dependent upon the State for part of the detection and dispatching, and for all of the labor. By law the Chief Forest Fire Warden was still responsible for the protection of the national forest, but by mutual agreement the Forest Service assumed responsibility for all its fires. This cooperative arrangement grew and functioned fairly well without benefit of written instructions. However, a series of misunderstandings occasionally resulted in a larger than average fire.

Two years ago the Chief Forest Fire Warden and the Forest Supervisor decided that a memorandum of agreement was long overdue, and on May 12, 1949, they signed such an agreement. A summary of the more important points follows.

1. The Allegheny Fire Protection Boundary is the property line except that all private land of 100 acres or less entirely surrounded by national-forest land, or lying between national-forest land and a natural barrier, is included in the protection boundary.

2. The Forest Service is responsible for the suppression of all fires inside the boundary and the State is responsible for all fires outside the boundary.

3. Each unit is responsible for suppression costs within its area except that the State pays labor costs on fires suppressed by the Forest Service on private land within the protective boundary.

4. Time of yearlong personnel is freely exchanged by the two organizations.

5. All fire wardens and crews are State-appointed but are on immediate call when needed by the Forest Service. Some crews are equipped with State-owned fire tools, some with Forest Service tools, and some with a part of their tool complement from each source.

6. Prevention plans are integrated so that there is no duplication or omission in movie, literature, and poster display.

7. Wardens are trained jointly by the two organizations.

8. The Forest Service reports to the State, on a State fire report form, all fires occurring within the protective boundary.

Of perhaps more importance than the points just summarized is the fact that the top-level agreement permits district foresters and district rangers to enter into written agreement on reporting and dispatching. This leads to greater efficiency because these men are closer to the multitudinous details that are complicated by an over-lapping of the districts of the two organizations.

Detection service is furnished by five lookouts owned and manned by the Forest Service, four by the State, and one financed jointly by the State and the Bradford Oil Producers Association. Three other State lookouts just outside the national-forest boundary also supply detection service. All towers are equipped with radio, and the State has two frequency channels neither of which are the same as that allotted to the forest. Reporting and dispatching are done by national-forest ranger districts.

A new officer in either the State or Federal service has much to learn in short order, but two things are immediately apparent to him. The first is that he has literally twice as much trained overhead as a fire control unit normally carries; and secondly, the arrangement works.

Are Snags a Fire Problem?

For many years fire fighters have singled out snags as troublemakers. A recent study of nearly 12,000 fires in the national forests of Region 1 indicates that the fear of snags is warranted. More forest fires start in snags than in any other fuel component. More than 34 percent of all fires in Region 1 originate in snags. On the other hand, less than 10 percent of the fires start in green tree tops. Obviously green trees generally outnumber snags in northern Rocky Mountain forests. But in spite of this numerical superiority snags hold over a 3-to-1 edge as a breeding ground of fires. The study showed that the highest percentage of snag fires occur in the grand fir type, with the white pine and subalpine types in second and third positions, respectively. The smallest percentage of snag fires occur in the ponderosa pine type.—DIVISION OF FIRE RESEARCH, *Northern Rocky Mountain Forest and Range Experiment Station.*

FOOD POISONING IN FIRE CAMPS

Jack E. Handy

Staff Assistant, Fire Control, Wenatchee National Forest

No one thing can disrupt the organization on a large fire more than to have the fire fighters all become sick after eating a meal in a fire camp. The most often used explanation is that soap was responsible for these outbreaks. This is seldom the true cause.

Lloyd C. Ajax of the Chelan County Department of Health is one of our best fire cooperators and has worked in many of our fire camps. After helping out on several fires, he wrote us a letter on what he considered to be the causes of sickness in fire camps. The contents of the letter are considered of sufficient value to all persons interested in fire control to be quoted here.

"While working in the fire camp at Hovey Creek it was called to my attention, by several officials of the Forest Service, that outbreaks of diarrhea were experienced in nearly every fire camp organized this year. These outbreaks were generally attributed to soap on dishes. This assumption was probably wrong, since single service paper eating utensils were used in at least one of these camps. Soap is often blamed for such outbreaks, but usually the real cause is food poisoning by contaminated and improperly stored food.

"Food poisoning may be produced in three general ways. The first is what is known as *food infection,* and is caused by eating food containing bacteria which cause illness after growing and multiplying following ingestion. There are several kinds of bacteria which may be the causative organism.

"The second type is known as *food intoxication,* and is caused by eating foods containing toxins produced by contaminating bacteria which grow in the food. The difference here is, that the illness is caused by the toxin rather than the bacteria. The staphylococcus bacteria, common in colds, sinus infections, and infected sores, is the most common causative agent. These bacteria will produce dangerous amounts of toxin in many foods in as little as 5 hours, if temperature conditions are favorable. After the toxin is produced, it is not destroyed by ordinary cooking or boiling, and remember, the toxin is what causes the trouble. The symptoms of food intoxication usually appear within 1 to 6 hours after eating food containing these toxins. Botulinus belongs in this classification but has entirely different characteristics.

"The third type is *chemical poisoning,* due to contamination of food by poisonous chemicals such as insect powders or from certain metallic utensils. It is important to know that the presence of these causative agents do not necessarily change the appearance or smell of food.

"To prevent food poisoning outbreaks, it is necessary to purchase sanitary food from reliable sources, see that it is handled by clean food handlers

in a sanitary manner, and store all perishable foods at a temperature below 50° F. Bacteria do not multiply or produce toxins rapidly below this temperature.

"From what I have seen of your fire camps, I would make the following suggestions to improve the sanitation and lessen the possibility of sickness in camp:

1. Be sure of a safe water supply.

2. Replace the cooking utensils having open, hard to clean, seams. Food remains in these seams and serves as a 'seed' for bacterial contamination.

3. Sanitize all eating and cooking utensils after washing, with water above 170° F., or use a warm (not hot) water rinse containing 1 tablespoonful of clorox or similar chlorine solution per gallon. Do not dry dishes with a towel. (Paper utensils are a simpler solution, when available.) The purpose of sanitizing eating utensils is to prevent the spread of communicable diseases.

4. Store utensils in a clean place and keep them covered.

5. Refrigeration—All perishable foods, such as potato salad, mayonnaise, prepared sliced meats, and all other meats and foods containing eggs and milk should be stored at 50° F., or less. Sandwiches containing these foods should not be without refrigeration for more than 5 hours. It would seem advisable to me to have a portable mechanical refrigerator for use at base camps where quantities of food must be kept for some time. This will save food as well as prevent sickness.

6. Storage of food—Keep all foods covered and protected from dust and flies.

7. Cleanliness of employees—Do not have any food handlers working who have a communicable disease or infected sores. See that only food handlers dish up food. Provide clean aprons and cloths for food handlers (it is easy for clothes to become contaminated with intestinal or other bacteria in a rapidly constructed camp). Provide separate hand washing facilities, including soap and sanitary towels, for food handlers, and see that they are used.

8. Camp sanitation—Take care of all wastes, garbage and sewage, to prevent the attraction of flies and rodents.

"In concluding, I would like to say that the general sanitation, other than food handling in these rapidly constructed camps, is very good. The food handling problem in a camp is always more difficult than in a permanent kitchen because of lack of proper equipment, location, and the fact that many camp cooks are not aware of the way food poisoning and diseases are spread.

"The danger of food poisoning is no greater now than in the past, but since we now know the cause and ways of preventing food poisoning, there is no reason to tolerate it. A man affected by food poisoning is worthless as a fire fighter for several hours or days."

MONTANA RURAL FIRE FIGHTERS SERVICE

George W. Gustafson

State Coordinator, Montana Extension Service

Prior to 1942 there was no plan for rural fire control for farm, range, and forest lands outside of organized fire protection districts. On February 11, 1942, the United States Secretary of Agriculture issued a memorandum assigning certain wartime responsibilities to State and Federal agencies, including that of organizing rural America for defense against destructive fires. Implemented by this memorandum, the State Board of Forestry sponsored a State-wide meeting in May 1942 to consider a rural fire control plan for the State. The Governor served as ex-officio chairman of the meeting and representatives of 14 Federal and State agencies were present.

The "Montana Forest Fire Fighters Service" was organized as a result of this meeting, an executive committee was elected, and a State coordinator employed. In the spring of 1945 the name of the organization was changed to the "Montana Rural Fire Fighters Service," dropping the word "Forest," because its primary function is protection from fire not only of forest but also of farm and range land.

The Montana Rural Fire Fighters Service is a voluntary organization maintained through the efforts and interests of the following agencies and associations:

U. S. Army
U. S. Department of Agriculture Council
U. S. Indian Service
U. S. Bureau of Land Management
U. S. Forest Service
Soil Conservation Service
National Park Service
Production and Marketing Administration
Farmers Home Administration
Montana Rural Electrification Assn.
Montana County Commissioner Assn.
Montana State Highway Patrol
Montana State Board of Forestry
Montana State Highway Department
Montana Fish and Game Department
Federal Bureau of Investigation
Private Timber Protective Agencies
Montana Extension Service
Montana Flying Farmers and Ranchers Association

Montana Rural Electrification Association and Montana Flying Farmers and Ranchers Association were added during the past year.

State coordinator is George W. Gustafson of the Montana Extension Service, reappointed to serve his fourth year in that capacity, devoting one-half of his time to the work of the Montana Rural Fire Fighters Service and one-half to the duties of the position of county agent supervisor with the Extension Service.

The State has been divided into twelve fire control districts. A district coordinator is appointed in each district to promote and coordinate all fire control efforts and to develop a program of fire control with the help and cooperation of all agencies concerned within his district.

Through the efforts of the Montana Rural Fire Fighters Service an act to provide protection and conservation of range and farm resources was passed by the 1945 Legislature. This act provides for rural fire protection

and control under authority of boards of county commissioners. Each board may appoint county and district rural fire chiefs, organize rural fire control crews, appropriate funds from the general fund of the county, levy a tax, or enter into cooperative agreements for fire control. The boards are authorized to fix closed season when burning is prohibited except through permits issued by the fire chiefs. This law is permissive rather than mandatory.

The board of county commissioners and the county organization form the basis on which the work of fire protection and control must be carried on. An effective organization and fire control program depends on the cooperation of all agencies interested in and capable of contributing to it.

The success of the Montana Rural Fire Fighters Service can best be measured on the county level, and much has been accomplished in fire prevention and control since the organization came into being, as indicated in the following summary of rural fire prevention and control activities in Montana, 1947-50:

		1947	1948	1949	1950
Counties organized under State law	number	53	53	53	54
Meetings held by county fire boards	do.	31	22	20	20
Members on county fire boards	do.	449	300	254	199
County and district fire chiefs appointed	do.	1,072	861	1,260	1,063
Public meetings held	do.	49	49	62	105
Attendance at public meetings	do.	2,045	1,158	1,913	2,319
County closed fire seasons declared	do.	17	13	23	20
State and Federal agencies giving local representative cooperation	do.	17	18	16	16
Amount of rural fire control budget set up by boards of county commissioners	dollars	16,544	16,411	17,585	21,600
Rural fires:					
Units burned	number	293	280	385	160
Estimate of loss	dollars	382,931	560,493	987,950	390,830
Volunteer fire fighters	number	2,025	2,144	4,190	1,248
Estimated saving	dollars	523,280	599,500	605,635	231,200

Every county, except two, has provided fire protection under the authority vested in the board of county commissioners by the Rural Fire Control Law. County fire chiefs and district fire chiefs within the county have been appointed. Large sums of money have been invested in fire fighting tools and equipment. Local fire fighting crews have been organized and trained in methods of fire fighting. Closed fire seasons have been established during seasons of dangerous fire hazards. In 1950, 453 volunteers attended 17 county training schools.

A system of reporting all rural fires has been in use for 4 years. District rural fire chiefs report to county fire chiefs or county extension agents. These in turn send the reports to the State coordinator, who makes monthly and annual summaries for the State. These reports give nature of fires, causes, losses, number of volunteer fire fighters, and estimated savings effected through work of fire fighting crews and use of tools and equipment. The summaries are published monthly in the "Rural Fire Flashes."

Voluntary fire control boards or committees are organized in most of the counties to plan fire control programs and advise with the boards of county commissioners on the needs of the counties on fire prevention and suppression. These committees usually consist of representatives of State and Federal agencies having range or forested areas within the counties, members of boards of county commissioners, county fire chiefs, district

chiefs, county extension agents, and others interested in fire prevention and suppression on the range, in crops, and in the forest. The following program for rural fire prevention and control to be followed in Montana has been set up:

I. An active fire control committee, which should be part of the county planning committee.
   A. Membership to consist of:
      1. Member of planning committee.
      2. One or more members of the board of county commissioners.
      3. County fire chief.
      4. One or more district rural fire chiefs.
      5. Representatives of the Federal and State agencies in the county.
   B. Meeting to be held in winter or early spring to plan season's program and agree on division of responsibilities on part of all cooperating agencies.

II. Prevention measures.
   A. Inform all farmers and ranchers of fire prevention program.
   B. Place posters and signs warning of fire dangers and hazards.
   C. Request individual farmers and ranchers to check premises seasonally.
   D. Use press, radio, and news letters for publicity.
   E. Secure cooperation of railroads for safeguards against fires.
   F. Work with State Highway Department.
   G. Determine where to place emphasis this year.

III. Reporting.
   A. All fires in the county are reported to county agents or fire chiefs.
   B. County reports all fires to State coordinator.

IV. Training schools and demonstrations.
   A. Discussions (Moving pictures can be used to depict one or more of the following points).
      1. Rural fire control under present legislation.
      2. County organization.
      3. The place of the volunteer.
      4. Communications.
      5. Organization in the fire line.
      6. Fire fighting techniques.
      7. Equipment and its uses.
   B. Field work in use of tools and equipment and organization of crews, and a fire suppression demonstration.

Representatives of State and Federal agencies responsible for administration of State and Federal lands have given most valuable support to the fire control program. The Extension Service has accepted the responsibility of carrying on an educational program of fire control, and has assumed leadership in planning the work. Fire control is one of the projects or activities of the county extension programs in all counties. In cooperation with the volunteer county fire control committees, plans are developed early each year, and the fire control program to be carried on in each of the counties and the goals are determined.

"Missouri Wash": A New Degreasing Preparation

Richard "Dick" Chatham, chief foreman of Stockton Equipment Depot, Stockton, Calif., has developed a degreasing preparation (or cleaning solution) nicknamed "Missouri Wash." The preparation is particularly effective for removing oil or other greasy substances that collect dust and grime on engines and other parts of tractors, motor graders, and other vehicles.

"Missouri Wash" was developed primarily to remove preservative paint from Army equipment prior to repair work. The preservative paint (Army Specification AXS-673-P1), a black, tarlike substance, presented an uncommonly difficult problem of removal. Special commercial cleaners proved only partially effective, and were prohibitive in cost and a menace to health because of strong chemicals and toxic vapors. The degreasing preparation "Missouri Wash" proved satisfactory and also offered an economical and safe means of cleaning engines and other parts subject to collection of oily grime. Less cleaning material and labor are required to do the job. Health menace and fire hazard are reduced to safe limits, due to practically nonharmful ingredients and high flash (fire) point of the solvent.

The use of "Missouri Wash" requires the same precautions governing the use of plain solvents. It should not be sprayed unless ventilation is plentiful, and should never be applied to a hot engine.

"Missouri Wash" is composed of Stoddard Solvent and common corn starch. The solvent is a natural dissolvent agent for oil or asphaltic base substances, but is quite fluid and evaporates rapidly. The corn starch serves as a holding agent and evaporation retarder, thus increasing the inherent dissolvent action of the solvent. Corn starch may ordinarily be purchased from wholesale grocers in 100-pound containers for about 8 cents a pound.

Instructions for preparation and application of "Missouri Wash" are as follows: Add corn starch to Stoddard Solvent in a proportion of 3 to 6 pounds to 1 gallon, depending upon consistency desired. Stir to mix. A thick consistency is desirable for vertical or overhead surfaces, or when surfaces to be cleaned are heavily coated; a thinner consistency for spraying, or when substance to be removed is loose and dissolves readily. Apply with brush or spray as a saturating solution, not as a wash, and in the least quantity necessary. Let soak for 20 to 30 minutes, depending upon conditions encountered, then wash with hot or cold water, or steam. (Steam damages paint and should be resorted to only in extremely difficult cleaning operations.) In some instances, a repeat process will be necessary. If water or steam is not available, use straight solvent to wash off the dissolved material.

Mix only in sufficient quantity for daily use, and preferably, only in quantity for immediate use. The corn starch has a tendency to precipitate and solidify at the bottom of the container unless solution is frequently stirred. "Missouri Wash" will not harm permanent type paints.

"Missouri Wash" should be the answer to the common and difficult equipment cleaning problems which continually face the field. Application for patent is pending. However, "Missouri Wash" may be used by the Forest Service and other government agencies which may choose to do so.—LESTER K. GARDNER, *Administrative Assistant, Division of Engineering, Region* 5, *U. S. Forest Service.*

PORTABLE HEADLIGHT UNIT FOR TRACTORS

ORVILLE LIND

Assistant Ranger, Allegheny National Forest

A handy portable-headlight unit for tractors and bulldozers not equipped with regular headlights can be assembled from a discarded truck head lamp and a home-made universal mounting bracket (fig. 1). The headlight used is a pre-1940 type, the kind not built into the truck's fender. Its glass, reflector, rim, case, and wiring circuit must be in good condition. The positive lead wire should be long enough to reach the positive battery terminal or the live side of the ignition system; the negative side is grounded to the tractor frame by means of the universal bracket. This system will not work with tractors having magnetos.

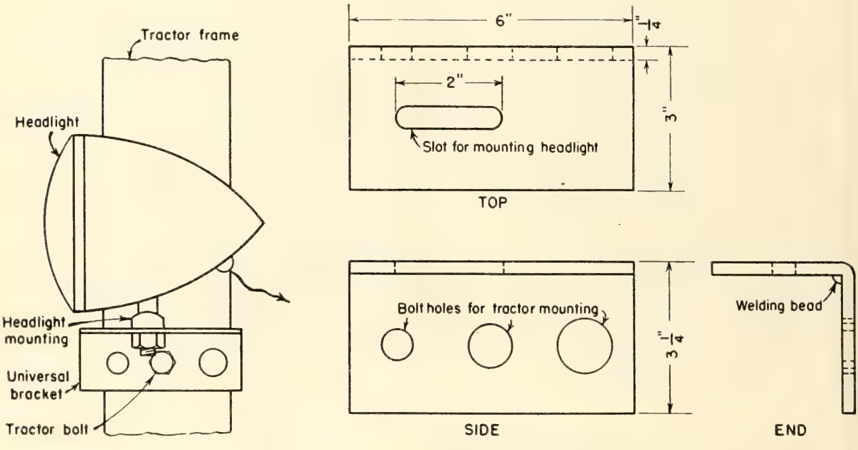

FIGURE 1.—Assembly of portable headlight unit for tractors.

The light can be quickly attached to the front of the tractor frame by means of a universal mounting bracket. This bracket is made of 1/4-inch iron plate, 6 by 6 1/4 inches, or from 1/4-inch angle iron, 3 by 3 1/4 by 6 inches. If 1/4-inch iron plate is used, bend to the dimensions of the 1/4-inch angle iron. On one end of the 3- by 6-inch face, make a 2-inch slot slightly larger than the diameter of the headlight mounting bolt. On the 3 1/4- by 6-inch face, drill two or three bolt holes of different diameters so that one will fit the bolt of any tractor on which the unit may be used. The angle of the bracket should be reinforced by a welding bead. Slight variations may be necessary in the mounting bracket so that it will fit the type tractor on which the light is to be used. The bracket can be made for a right- or left-hand unit.

Paint the light fire red and attach it to the mounting bracket slot by means of the headlight bolt. Bolt the bracket to the frame and attach the positive lead wire to the positive battery terminal for a check on wiring and lighting.

This portable tractor headlight was developed to meet a special need of the Allegheny National Forest. Here, lease tractors can usually be rented more quickly and cheaply than Forest Service tractors can be transported to a fire. Because the rented equipment often lacks adequate lights for night work, each district fire cache has a box of four portable headlights ready for use. In addition to the lights, the box contains wrenches, friction tape, and extra light wire.

Flammability of Chaparral Depends on How It Grows

Southern California chaparral has long been noted for its flammability, which is usually ascribed to the general character of the vegetation, steep slopes, and severe weather conditions. Probably not enough emphasis has been given to changes in the vegetation itself that affect its fuel qualities.

All evergreen California chaparral species normally grow new twigs and leaves in the spring and drop a portion of the older leaves in the summer and fall. For the canopy to reach full development, after this type of vegetation is first established, usually requires 8 to 12 years, during which time little dead wood or litter is produced and fire presents no particular problem.

When the site becomes fully occupied, annual production of new twigs and leaves is balanced by the death of older branches and leaves. In normal years there is a seasonal cycle in flammability caused by an increase in numbers of leaves with high moisture content in the spring, then a decrease in numbers and a decline in leaf moisture in summer and fall. Normally, this annual cycle of balanced growth and death causes a gradual build-up of dead fuels. But flammability is usually kept within reasonable, though seasonally variable, limits by the slow compacting and decay of accumulated litter, and by the overstory of green leaves which shields against sun, wind, and desiccation.

This normal state of affairs has been upset since 1945—the beginning of the present southern California drought. By 1948 the shortage of rainfall began showing its effects by the appearance of individual dead bushes scattered over the landscape.

By the beginning of the 1950 fire season the topsoil was powder dry. In some areas there was little if any growth of new leaves; more old leaves, too, had fallen. Instead of full-bodied dense crowns, thin, transparent, drab-colored foliage met the eye. By midsummer the chaparral looked and felt parched. That it could be so dry and still be alive was unbelievable. The canopy over large areas was punctured with stark, dead branches, and many more than the usual number of dead shrubs could be seen.

This marked change in growth—or lack of it—meant a much higher than normal ratio of dead to green fuel, extremely flammable foliage, higher fuel temperatures from increased exposure to the sun, more freedom of air movement—meaning more wind close to the ground.

Years of drought are often characterized by low humidities and high temperatures. These occurred often in the summer of 1950. The lack of moisture in soil and vegetation also held the pickup of humidity and fuel moisture at night to a minimum, resulting in extra long daily burning periods.

The combination of deteriorated cover and severe weather had by 1950 reached the point of near-maximum conflagration potential. By May this year the southern part of the State had received only half or less of its normal seasonal rainfall; very little more is expected. The outlook for the 1951 southern California fire season is thus for more thinning and dying out of shrubs with a consequent increase in flammability beyond anything yet experienced in our time.—Charles C. Buck, *Division of Fire Research, California Forest and Range Experiment Station.*

COLLAPSIBLE FIRE CAMP TABLE SUITABLE FOR DROPPING FROM AN AIRPLANE

R. Boyd Leonard

Fire Control Officer, Salmon National Forest

The collapsible table plan shown in the January 1951 issue of Fire Control Notes inspired the personnel of the Salmon National Forest to study ways of breaking the table on down into a parcel small enough for dropping from a plane of the Ford Tri-motor type and one that could be packed easily on a pack horse. It was generally believed that these could be dropped with a supply order and would materially improve the facilities in the early stages of a fire camp. They could also be used at camps accessible by motor vehicle.

The table that was built is compact and light. It has no parts that are not fixed securely. Material used is ¾-inch plywood, strap hinges, door hinges with removable pin, a few feet of light chain, and some screws.

In figure 1 the braces can be seen mortised into keepers on the bottom side of the table. The chains are fixed at both ends and work automatically. The lower shelf board slides into place and the two parts of the door hinge are fastened securely together with the pin. Figure 2 shows door hinge with pin in place and the two braces removed from the keepers and in place to give rigidity to the table. The two lengths of chain are now tight and held that way by the braces.

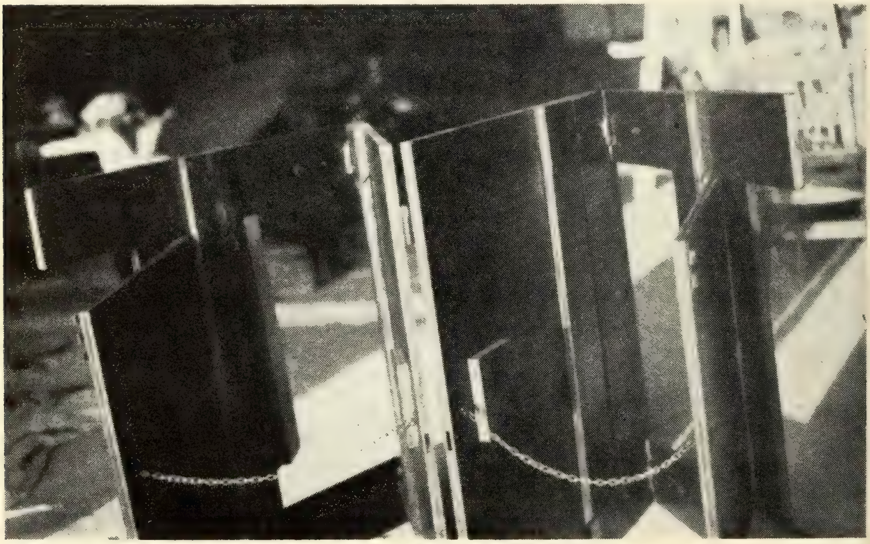

Figure 1.—Collapsible table partly opened. Note location of braces when table is folded.

When the table is in use the strap hinges are necessarily on top (fig. 3). These could be turned over and mortised into the top to lie flat with the surface. For a camp table, however, the hinges as shown will likely not prove objectionable and it is believed that they give more strength against twisting or sudden blows.

It is planned to give the table a thorough try before reporting on the success of this development.

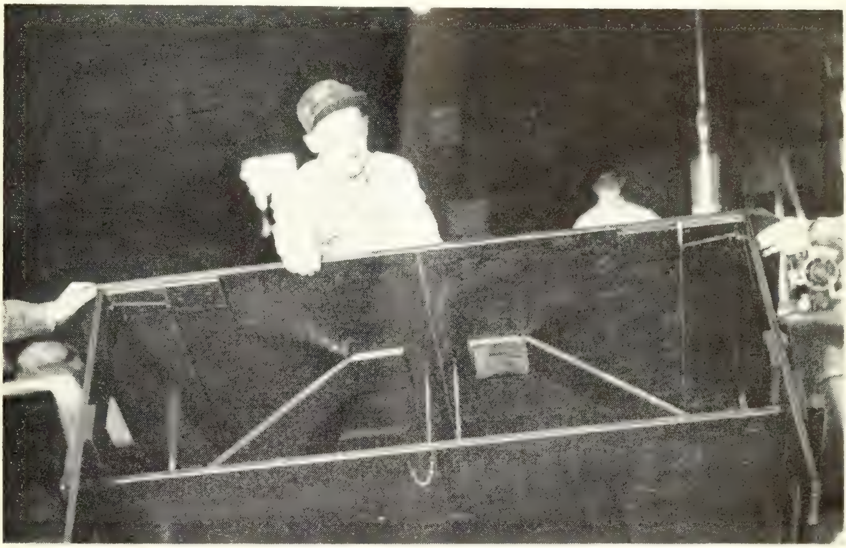

FIGURE 2.—Table assembled with door hinge pins and braces in place.

FIGURE 3.—Fire camp table ready for use.

BUTANE-DIESEL FLAME THROWER

Arcadia Equipment Development Center

California Region, U. S. Forest Service

An article, "A New Mobile Flame Thrower," by Henry Wertz, Jr., and C. Vernon May, of Los Angeles County Department of Foresters and Fire Wardens, appeared in the October 1946 issue of FIRE CONTROL NOTES. The unit described was a trailer-mounted power flame thrower, using butane and Diesel for fuel.

This unit has proved very successful in backfiring under adverse burning conditions. Such conditions have a tendency of developing rapidly in coastal areas, because of fog rolling in from the ocean.

To meet the increasing demand for these backfiring units, three trailer units were built in 1950 at the U. S. Forest Service Equipment Service Shops at Arcadia, from existing blueprints and information supplied by Los Angeles County Department of Foresters and Fire Wardens, and with recommended features for better performance and safety added. Most of the necessary information for designing the revised unit, which has been proved safe and efficient, was provided by the personnel of Los Angeles County who were responsible for the original development.

This flame thrower is designed to project a very hot flame for a considerable distance. This is accomplished by using a cheap but safe fuel, Diesel oil, which is ignited by passing through a butane flame. The ignited Diesel is projected 30 feet or more by means of compressed air (fig. 1); some Diesel fuel is deposited on the ground to maintain a flame. The primary purpose of the butane is to produce a sure-fire ignitor for the Diesel fuel.

F-465836

Figure 1.—Flame projected by the butane-Diesel flame thrower.

However, butane alone produces a flame which carries 3 or 4 feet, and is very effective for igniting light forest cover.

The unit is mounted in a sturdy trailer with a wide wheel base and a low center of gravity (fig. 2). The tongue of the trailer is equipped with two hitches, one for secure and safe trailing behind a truck on the highway, and the other for pulling behind a tractor.

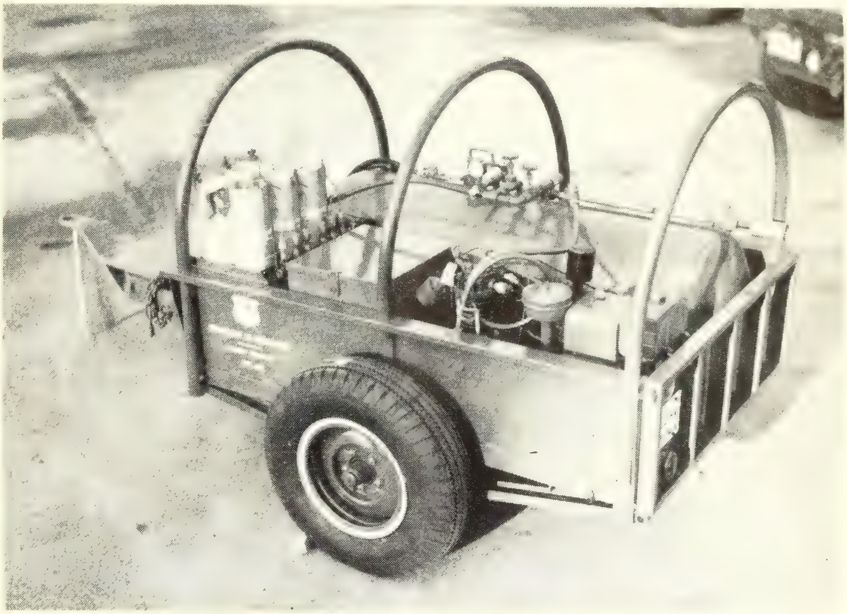

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FIGURE 2.—Backfiring unit mounted in trailer.

Three "crash bars" are installed over the trailer to protect equipment in case of an upset. Experience in the past has revealed the necessity of such protection.

The revised unit has a 120-gallon tank in which approximately 100 gallons of Diesel is placed, to allow room for compressed air. Near the center and at the top of the Diesel tank are five holes to serve as inlets and outlets for fuel and air. One has an internal dip pipe extending down to within one-half inch of the bottom of the tank, serving as a discharge line for Diesel. At the top of this pipe is attached a hose for supplying Diesel for the firing gun.

A second hole takes a pipe, tapping the air space at the top of the tank, which is also connected to the Diesel line and equipped with a valve so that the hose and gun can be purged of fuel by an air stream. As a safety precaution, a pop-off valve that opens at 150 pounds pressure is installed in this line.

A third hole, near the fill spout, takes a valve which serves as an escape for the compressed air. The handle of this valve projects over the fill spout so that the cap cannot be removed until the valve is opened.

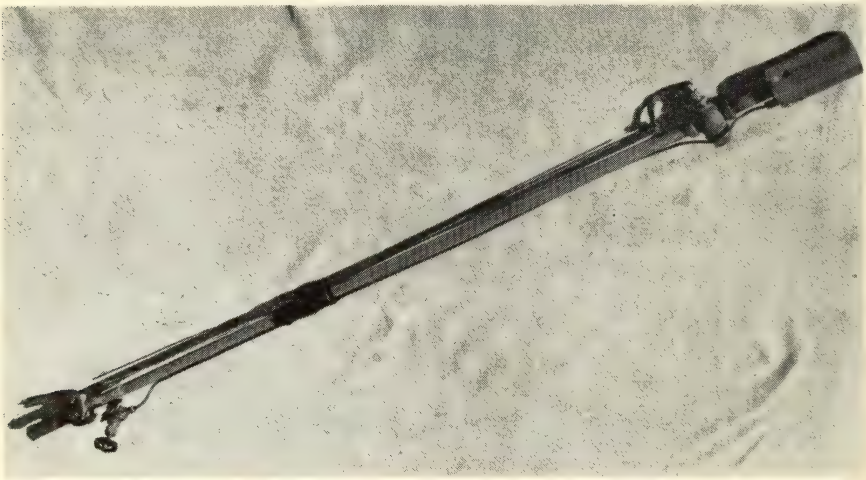
The fourth hole serves as a fill spout, and the fifth as an intake for air from the compressor

The six small butane tanks fit into a rack and are securely fastened in place. They can be replaced when empty without interrupting operation, as only two are in use at a time. Six copper tube lines connect them into a manifold, with six valves located adjacent to the manifold. These valves permit closing of any number of the six lines for replacement of the butane tanks, or isolation of any leak or break. A regulator and gage are installed on the manifold outlet to control butane pressure to the firing gun.

A compressor, run by a 5.1 horsepower engine, supplies the compressed air to the space in the top of the Diesel tank. An adjustable pressure relief valve installed in the bypass line allows setting to any pressure desired. (For Diesel fuel the best operating pressure for ignition and projection was found to be 80 to 110 pounds.)

Two 50-foot lengths of three-ply oil-resistant hose connect the fuel tanks with the firing gun. This heavy hose is deemed advisable as a factor of safety.

The gun is 5½ feet long, made of ¾-inch pipe, with a special built brass firing nozzle (fig. 3). Flow of butane is regulated by a globe valve installed near the handle. From this valve, copper tubing extends to the tip, fastened along the pipe, for delivering butane to the firing nozzle. Guns designed for the first units had a quick-throw valve mounted near the tip and regulated by a remote control wire to a trigger on the handle. This caused the gun to be front heavy, so in the later design the quick-throw valve is mounted on the handle.



F-465835

FIGURE 3.—Firing gun of the butane-Diesel flame thrower.

A check valve installed at the tip traps the Diesel in the barrel when pressure is shut off. Even after making this change the gun is heavy for continued use by one operator, but, because of excessive heat, operators will of necessity change off frequently.

The ⅜-inch hose and 5/32-inch tip use 4.8 gallons of Diesel per minute, and 21 minutes of continuous firing is obtained from one tank of Diesel

(100 gallons). With the very hot flame and long projection of the flame, continuous firing would be rare. However, this might occur when backfiring along a road, in which case additional fuel could easily be supplied. It is feasible to use a $\frac{1}{8}$-inch tip and $\frac{1}{4}$-inch hose, which would increase operation time without refueling, and still maintain good flame projection.

Since this trailer unit is designed primarily for towing behind a tractor, its capacity and weight have been increased considerably over those of the original models built in 1946. The additional capacity of the fuel tank provides longer operation without refueling. Weight is so distributed in the trailer that the front end is heavy, but is still sufficiently light for one man to attach the trailer hitch. Cost of the unit complete with trailer in March 1951 was $1,400.

Further details and specifications are available in drawings F-26-01 to 04, at the Arcadia Equipment Development Center, U. S. Forest Service, 701 N. Santa Anita Ave., Arcadia, Calif.

World-Wide Distribution

FIRE CONTROL NOTES, with less than 5,000 copies of each issue, probably sets some kind of a record for wide distribution. About half of each issue goes to Forest Service personnel. Other Federal and State agencies having fire control responsibilities also receive it regularly, as do many privately financed fire control organizations.

The larger libraries maintain complete files of the NOTES. Forestry schools, corporations, timberland owners, consulting foresters, and other interested companies and individuals receive it.

Canada leads all other countries in the number of copies distributed outside of the United States. Copies are sent to individuals or agencies in 70 different foreign countries—from South Africa to West Australia, from Burma to Iceland.—E. ARNOLD HANSON, *Information Specialist, Division of Information and Education, U. S. Forest Service.*

A SLIP-ON ATTACK UNIT

EINAR E. AAMODT

Engineer, Region 9, U. S. Forest Service

A 1-ton, 4-wheel-drive pickup has been equipped at Michigan's Roscommon Shop for fire fighting with a slip-on tanker, slip-on pump, and slip-on hydraulically controlled plow. Special 9:00x13:00 tires provide flotation and good traction. Road clearance is 8½ inches. A special heavy-duty 15-gallon gasoline tank is installed on the right running board. Two overload long spring leaves are added on each side in front. Heavy, 2x½-inch angle iron armor is used on the sides, running boards, and fenders; heavy 5-inch channel bumpers are provided front and rear. Two back-pack pumps are mounted in the rear of the fenders, and a flame torch on the heavy-duty gas tank (fig. 1). These can easily and quickly be replaced or removed, and are well protected from damage by brush and trees. Hand tools are carried in the large tool box under the front seat cushion. Two tow hooks on the front frame, and a ball hitch on the rear are provided. There is room for two single seats in the rear of the truck. The wide cab seat can accommodate three persons.

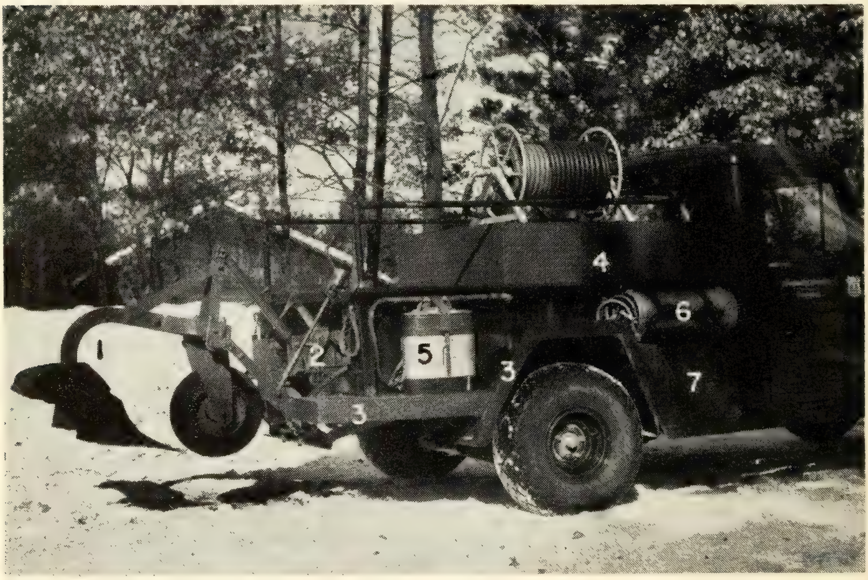


FIGURE 1.—Pickup equipped as a fire fighting unit: (1) Plow; (2) hydraulic lift (pump not shown); (3) bumper and fender armor; (4) water tank (245 gallons) with live hose reel; (5) back-pack pump (one each side); (6) backfiring torch (under body flange); (7) special heavy-duty gas tank.

The 245-gallon water tank used is 48 by 48 by 26 inches high. The tank is equipped with 6-inch rollers and can be easily rolled onto a platform when filled with water. It is held securely in place by two ¾-inch slide pins in the front of the body, and an easily removed ½-inch bar across rear of tank, fastened through each side of the pickup body. A live hose reel, with Chickson joint and 300 feet of ¾-inch hose is mounted on the tank. Hose connection from the pump to the reel and the 1½-inch hose connection to the tank are the quick pull type and can be easily and quickly engaged or disengaged.

The slip-on plow is a modified Monroe hydraulic plow. It is easily removed from the three-point carrier by pulling three pins. The plow lever and level float arms are also removed by pulling pins. The hydraulic cylinder unit is mounted on a single steel plate, along with the pump, and this entire assembly can be removed by pulling two hand pins. A double hose break-away no-leak coupling is installed in the hydraulic hose line and can be coupled or uncoupled without tools and without loss of any oil, and this can be done with or without pressure on the oil line.

The new style large-size modified Jeep plow with high lift, has the hydraulic control levers on the steering column. The plow operates on a level float arrangement and does not require adjustment when the water load is decreased. When the plow has been raised as far as it will go the pressure valve whistles indicating that the lever should then be moved to the neutral position. When the plow is down in plowing position the control lever can be put in neutral position and left there, allowing the plow to float without any down pressure. Pressure, if needed, can be applied to the plow by leaving the control lever in the down position. A button screw arrangement on the oil reservoir valve provides adjustment to increase or decrease the pressure to the plow. Full maximum pressure of 500 pounds per square inch in the hydraulic system is obtained when the button is all the way in. Each half turn clockwise reduces the pressure about 85 pounds per square inch. Once the desirable pressure point is found, the adjustment is left there until soil conditions change.

The hydraulic pump is mounted on top of the engine head and is powered by a V-belt drive. A slip pin makes it easy to disconnect the pulley drive and disengage the pump. The pump should be disengaged on long trips and when the plow is removed.

When the plow is raised upright (in carrying position) it cannot be operated. The trailer hitch may be used when the plow is upright.

The modified Willys plow, which is the same as the modified Jeep plow except for the greater width of the turf knives, makes a fire line approximately 60 inches wide, with furrow bottom width of 20 to 21 inches and depth of 3½ to 4 inches. Most plowing is done with the plow in floating position, without pressure from the hydraulic pump.

The pump slip-on unit is mounted with a hydraulic cylinder (plow) unit, on a ½-inch mild steel plate (fig. 2). This entire assembly can be easily removed by pulling two hand pins which extend through the reinforced floor of the truck. The pump is chain drive, 3 speeds, from the rear power take-off. A ⅝-inch pitch roller chain drive is used. A short shaft with a universal joint and sprocket drive is mounted along-

side of and parallel to the hydraulic cylinder unit. A short channel bumper bar is bolted in place in the center of the rear bumper, giving full protection to the power take-off when the truck is put to other use.

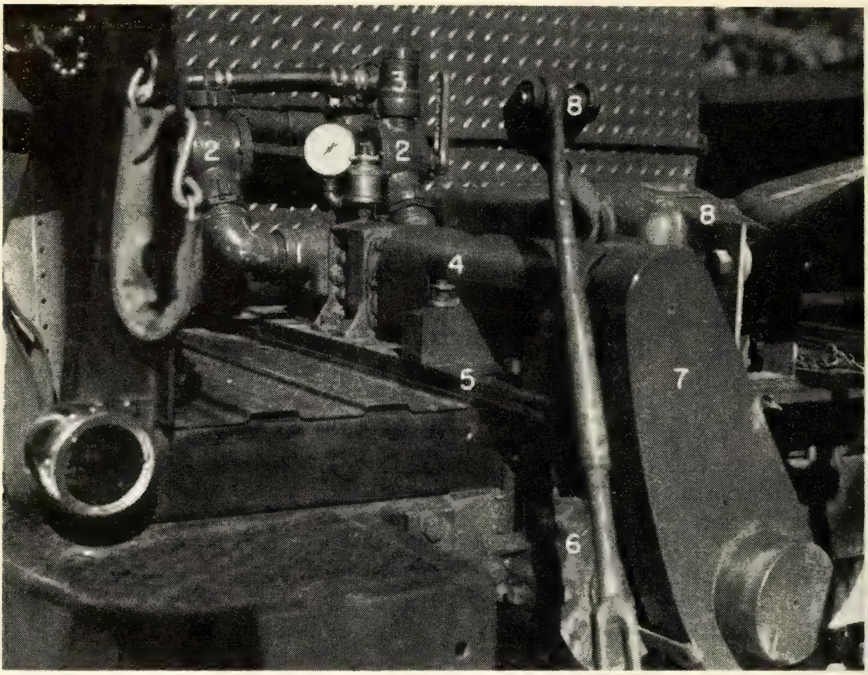


FIGURE 2.—Pump slip-on unit: (1) pump; (2) siamese valve; (3) automatic pressure valve; (4) drive shaft cover; (5) plate on which pump and hydraulic lift mechanism is mounted (fastened to bed of truck by 2 pins); (6) power take-off for lift mechanism; (7) roller chain drive cover; (8) lift mechanism.

Two valves, with handles pointing in the direction of the flow of water, and a pressure release valve that feeds the excess water back into the pump, are used in the pump unit. A cap is provided so that the unit can be operated as a stationary pumper using 1½-inch hose, and a second cap allows attachment of a suction hose. A slotted forestry type hose connection is provided between the tank and pump, and a 14-inch length of rubber suction hose is used to absorb vibration between the pump and tank. The tank outlet is equipped with a 1½-inch gate valve so the water can be contained when the pump unit is removed.

Adequate pump speed was determined for the lowest forward speed (low-low), and more than enough water is provided. When used as a stationary pumper the pump can be run at three different gear shift speeds (low-low, intermediate-low, and high-low), so the engine can be run at a relatively low speed while the pump operates at a high speed. The pump will deliver 50 gallons per minute free flow and 23.7 gallons per minute at 150 pounds per square inch pressure. Flow can be reduced with small nozzle to 3 gallons per minute at 200 pounds pressure, with the excess water bypassed back to the pump. The pistol grip type gun used

with this unit has an easily operated single trigger control with locking device that gives complete quick shutoff to fog, spray cone, or straight stream. Five sizes of nozzles are provided to give a choice for light or heavy (slash) fuels, the largest size being ¼ inch or 20 gallons per minute and the smallest 3/32 inch or 5 gallons per minute. Control of fog, any width of cone spray, or straight stream of water is excellent, regardless of size tip used. No wrenches are required to change tips, and extra tips can be carried in a clip on the gun.

The slip-on unit can be removed or replaced without the use of any special tools or equipment and a complete change-over would ordinarily take less than 10 minutes.

The hydraulic plow lift and power take-off pump controls in the cab do not interfere with the normal operation of the truck when the plow and pump units are removed. The manipulation of the controls with the plow or pump removed causes no damage. The heavy armor of the fenders and sides and the front and rear bumpers does not interfere in any way with the normal use of the truck. It gives added protection for year-round use. A post-hole digger or other power belt attachments can be used with the hydraulic unit with or without the water tank or pump in place. The plow can be easily removed and a tree scalper or other attachment installed quickly.

Net weight of all equipment and full water load is 3,005 pounds; net weight of truck is 3,235 pounds; drawbar draft power for S-low gear (1 to 6 m.p.h.) is 3,240 pounds; drawbar required for plow is 800 to 1,200 pounds on the average. Five horsepower is required for pump at 150 pounds pressure.

The 1-ton unit handles the larger plow easily and most times without effort. Passengers riding in the cab usually cannot tell whether the plow is up or down. Tests indicate safe speeds, fully loaded, of 50 m.p.h. on highways, 40 m.p.h., on gravel roads, 25 m.p.h. on side roads and ways, and 6 to 15 m.p.h. in open field travel. Climb ability in grass sod and brush extends to 50-percent slope, and plowing to 32-percent slope. These tests were made with the 9:00x13:00 tires at 26 pounds pressure.

This truck with the new "F" head engine and flotation tires, and its all-steel cab, wide comfortable seat, good visibility, inside and outside rear-view mirrors, and heater and defroster, has a utility value for off-the-road and cross-country use in winter as well as in summer that is not equalled in any other unit. The truck rides comfortably, handles easily, and is reasonably economical to operate.

The rear channel bumper extends to the lower end of the rear fender, and has a piece of floor plate flush with the top of the bumper extending in to the body of the truck. This serves as a step plate and also as a mounting for the back-pack pump as well as affording protection and extra strength. The center portion of the bumper is removable to accommodate the plow unit. The bumper extends about 8 inches in the rear of the truck body to give protection while backing up. A brush guard is provided on the front end and 1-inch pipes extend from the outer ends of the front bumper to the ends of the front fender armor.

The tank is constructed of 16-gauge mild steel four-way floor plate and has angle-iron reinforcements in all corners and one set of baffle plates

run each way. Inside of tank is treated to prevent rust. Top cover is fastened with brass screws and can be removed to recoat or clean tank. The factory mounted gasoline tank was so low that debris and stumps damaged it, and there was also danger of puncture while on fire line. It was replaced by a special heavy-duty tank.

The larger tires and wheels appear to be a good investment if the truck is to be used for plowing and for extensive cross-country travel.

Rain That Does Not Affect Fires

Rain during the fire season is a blessing, but a blessing whose magnitude can easily be overestimated. Many a smokechaser has become soaked while traveling through open country and thereby lulled into a false sense of security, only to be rudely awakened by the enthusiastic behavior of a fire which apparently hadn't heard about the rain. The reason is that quite a lot of our precipitation never reaches the ground.

Data presented by Joseph Kittredge in his book "Forest Influences" show that the forest types of the northern Rocky Mountains intercept 8 to 43 percent of the total precipitation during the growing season. Interception varies inversely as the amount of precipitation in each storm. Showers of up to 0.04 inch may be completely intercepted by an unbroken forest canopy, while 55 to 75 percent of a 0.20-inch rain will probably reach the ground.

The importance of interception to fire control in Region 1 becomes apparent from analysis of precipitation per shower during July and August 1950. During this exceptionally wet summer, 26 percent of all showers brought 0.01 inch of rain or less, 47 percent 0.05 inch or less, 60 percent 0.10 or less. Thus it appears that about one shower in every three produces too little rain to reach the fuels beneath a heavy canopy. Indications are that perhaps another third of the summer storms do not get enough rain through the canopy to moisten fuels significantly.

Thus after a summer rain the normal order of fire behavior will usually be reversed for a time, with fires in green timber more active than those in burns and logged-off areas. And at such times the behavior of fires in the timber has a good chance of surprising firegoers, dispatchers, and unwary overhead.—DIVISION OF FIRE RESEARCH, *Northern Rocky Mountain Forest and Range Experiment Station.*

BLANKET BAGGER

Leon R. Thomas

Supervisor, Mendocino National Forest

A simply, efficient labor- and time-saving device for placing blankets in standard 10-blanket paper bags has been developed by Warehouseman Russell Burton of the Sequoia National Forest.

The device consists of a table 30 inches high with a top 26 by 24 inches and an angled bag holder 24 by 48 inches with a foot board (fig. 1). An old tatum is attached to the angle board so that the top lifts up and permits the paper sack to be clamped in the tatum jaws. The top is then turned down inside the bag and the blankets slide over it without pulling out the bag.

A piece of strip metal is attached to the table and part of an old clamp board is fastened to the top of the strip. This holds the upper part of the paper bag. The clamp on the metal strip is 1 foot from the table.

One man with the bagger can operate faster and more efficiently than two men without it.

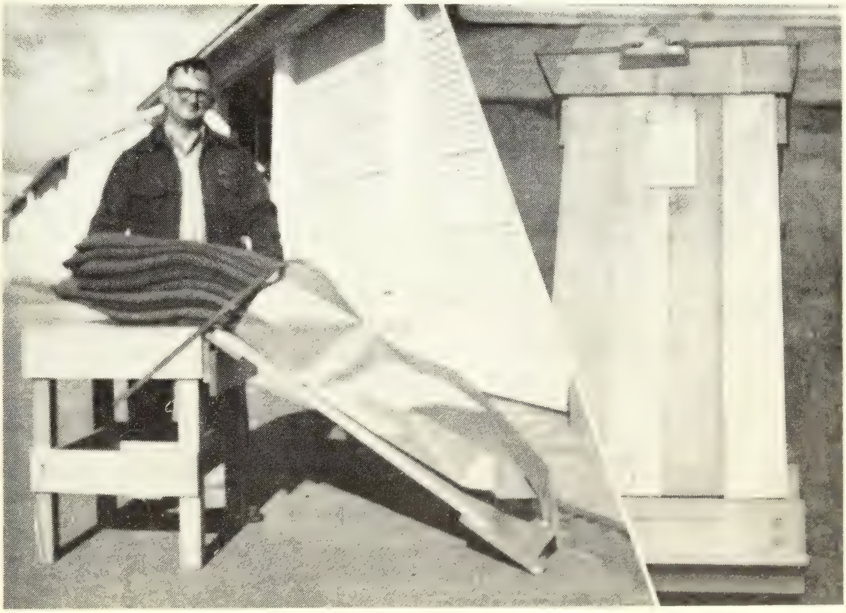


Figure 1.—Blanket bagger: *Left,* Warehouseman Burton operating bagger; *Right,* arrangement of tatum and metal strip with clamp.

FROZEN PREPARED MEALS

Leon R. Thomas

Supervisor, Mendocino National Forest

Complete prepared frozen meals, as now extensively used by the commercial continental and intercontinental airlines and branches of the armed forces, are well adapted to many Forest Service activities.

The basic meals consist of meat or fish, potatoes or rice, and a vegetable, placed in an aluminum or tinfoil plate and covered with a sheet of foil then quick frozen. Some companies pack the basic meal with bread, butter, a drink, salad and dessert, and disposable eating utensils to make a complete one meal unit. Other companies just pack the basic meal and the latter items must be added to round out the meal. Breakfast units are similarly prepared and packaged. They consist of eggs with bacon or ham, fruit and variable items.

The Sequoia National Forest experimented in the use of sixteen different individual types of meals during the summer of 1950. They were used in such activities as feeding men in fire camps and on the fire line to week long pack trips in the "back country." The results were very good in all cases. The types found most suitable to our needs were the basic plates of chopped beef, beef stew, pot roasts, swiss steak, roast turkey, chicken, and the egg and bacon breakfasts.

The meals must be handled and cared for in the same manner as all quick frozen products now carried in nearly all grocery stores. Dri-ice refrigeration can be used for transporting the meals and for packaging in sealed cartons for later use under field storage conditions.

Methods of heating the meals offer no complications. Almost any type heat can be used such as kitchen stoves (ovens or on top), gas field range or oven, open fire, covered campground stove or ice can stove, on top of and buried in a bed of coals, or special stoves distributed by the frozen food companies.

A few important advantages of the meals are:

1. Sanitary. They are packed under strict supervision and the bacteria count is very low. They do not spoil quickly after thawing. There is no chance for contamination until the cover is removed for actual eating.

2. Excellent quality and good quantity. The meals are of excellent quality and taste. Only the best of raw products are used. There are 11 ounces or more of eatable food in each basic meal. This, supplemented with bread, drink, salad, and dessert, is sufficient for the average man. For those who may want more, a few extra meals can be put in and divided up.

3. No waste. All of the food is eatable. There is no waste in preparation and little of the prepared food will be wasted.

4. No cooks needed. Professional cooks are not needed. Most anyone can heat the meals after a little experience.

5. Ease of handling. The units are light in weight, compact, and very easy to handle and store.

6. Nothing to retrieve. Everything is disposable—nothing to wash, nothing to retrieve. This is a most important factor in on-the-line use and in back country fires.

7. Stored for immediate needs. The meals are always ready—no cooking preparation needed. They can be transported where desired and made ready to eat in a minimum of time.

8. Less cost. Frozen meals can be purchased, stored, and made ready for use cheaper than meals prepared in present conventional fire camp methods.

9. Saving of manpower behind the line. Fewer men needed in service and camp jobs.

10. Delivered hot if desirable. The meals can be heated in a base camp and delivered to the line preheated, where transportation methods permit.

11. Keeps men on the line. The convenience and ease of handling makes it much more possible to keep men on the line, *where they are needed*, by serving them with frozen prepared meals by helicopter, cargo plane, truck, or mule train.

The meals are recommended for use in all types of administrative operations requiring road crews, construction crews, established camps, and the like. They are particularly recommended for use on the fire lines and in small fire camps where it is desirable that men *stay on the line*. They are excellently adapted for delivery by parachute and by helicopter.

Several forests in Region 5 are planning to use frozen prepared meals this year. Caution is urged in undertaking their use for the first time. New techniques and procedures are required. It is suggested you learn these before undertaking a large scale project.

Reference to companies supplying the frozen meals can be found in various frozen food journals, or secured from the Operation Division, U. S. Forest Service, 630 Sansome Street, San Francisco 11, Calif.

USE OF AIRCRAFT FOR FOREST FIRE DETECTION IN WEST VIRGINIA

A. E. France

Pilot, West Virginia Conservation Commission

The Conservation Commission of West Virginia has used an airplane in forest fire detection for the past 3 years. During this period the airplane has been flown more than one thousand hours. Six hundred and fifty hours was flown on fire patrol; the remainder was used for executive transportation, beaver dam survey, deer census, aerial photography, patrolling closed streams, and in fire control demonstrations for school children, 4-H Clubs, and Boy Scouts. In this 3-year period West Virginia had 3,498 forest fires reported. Of this number about 700 fires were reported by the pilot, making an average of more than one fire per hour flown.

On days of low visibility observation from towers is restricted to a few miles. Under such conditions the airplane patrols the area between the towers to give complete coverage. Visibility on many of our areas is poor because of smoke from many industrial plants and burning slag piles. When no wind is blowing a haze develops in the valleys and extends upward above the fire towers. The airplane can fly above this haze and spot fires that tower observers cannot possibly see.

A good example of this occurred one day in November 1948. There had been no wind for 24 hours and it was very hazy in the southern counties, making detection of fires by the towers difficult. While on patrol that afternoon the pilot spotted nine fires which would normally have been observed by the towermen.

There are times when a tower has a reading on a fire but is unable to get a cross-check from another tower. In some cases a smoke will drift a few miles in the hollow before rising. This makes it difficult for the towerman to give the exact location of the fire. The airplane is then used to locate the fire and help the suppression crew or smokechaser get to it without too much delay. Sometimes the smoke is from a legal burning, a condition which often cannot be determined from a tower. If this is the case, a determination from the air can save the forest protector a needless trip. Also, if the smoke happens to be from another source, such as brush burning or right-of-way burning, the forest protector can be notified and he can change his plan of action to suit the situation.

The airplane is very helpful in determining the size of a fire. While over the fire the pilot can relay information to the station or suppression crew concerning the terrain and whether the fire is burning slow or fast. He can also advise if it is possible to get to the fire by truck, car, or jeep, and if there are any barriers, such as pipe-line rights-of-way, strip mines, or streams, which may help in suppression of the fire.

A system of triangulation similar to that used by the fire towers has

proved effective in giving a more exact location of fires. Briefly, this is done by flying a compass heading from two known towns or locations, and at the point where the two lines intersect is the location of the fire. Best results come from a fix from two points that will give a 90° angle.

These uses indicate the value of the airplane in fire detection, but there are some disadvantages. It is difficult to locate fires accurately after dark, and flying single engine airplanes at night in mountainous terrain is not safe practice. A second disadvantage is that the airplane cannot safely be flown on days when the wind velocity is high. Both of these disadvantages could be partially eliminated with a small twin engine airplane but as yet there has not been an airplane built to meet this need.

Periods of high wind velocity are not frequent. We experienced extremely high winds for one 9-hour period on March 27, 1950. That day, we had 191 fires reported. These fires burned over twenty thousand acres in the 9-hour period. At 11:00 o'clock the pilot took off on fire patrol with a wind blowing from the south at about 20 miles per hour. By 12:10 the pilot had reported 14 fires in 2 counties and the air had become so turbulent that he could hardly hold his map, much less run an accurate fix on the fire. When he landed, the wind was gusting to 55 miles per hour. Later, weather stations recorded wind velocities as high as 72 m.p.h.

The West Virginia Commission's Stinson airplane is equipped with a radio and public address loud-speaker that is very effective from an altitude of 2,000 feet. This speaker is mounted in the right rear seat where a 12-inch diameter hole has been cut to emit the signal. The hole can also be used for aerial photography and for dropping of small parcels by parachute. It takes about 10 minutes to install or remove this speaker. With the speaker, the plane can carry three passengers. When the speaker is removed a plywood board is fixed over the hole and a metal plate is installed under the fuselage to smooth up the airflow.

Power output of the public address speaker is 50 watts, which is plenty without too much drain on the battery (fig. 1). Speeches should be short and well planned to cut down the drain on the battery and because time is limited over the area due to the speaker being mounted vertically in the airplane. Some speakers are mounted at an angle so that the address can be centered over one spot while the airplane circles the area. Both systems are good. With the vertical type best results can be obtained by flying upwind at reduced power and speed with flaps down. This gives a longer period over the area and the signal is forced downward by the flaps.

The speaker has been very effective in the control of brush burning. When a farmer is burning his brush too near the forest the pilot can warn him of the danger, and he usually puts the fire out. On many occasions the pilot gives locations of fires to local protectors when the county forest protector is engaged with other fires in his county. Another use of the loud-speaker is to give directions on going fires, especially when they are larger than usual and in rugged terrain.

The airplane also has a two-way radio operating on a frequency of 31.98 megacycles (figs. 2 and 3). This radio, designed for the Greyhound Bus Company, was purchased because it worked on a 12-volt system as does the airplane. The heavy base plates were removed and replaced by aluminum to lighten its weight considerably.

FIGURE 1.—Loud-speaker and 50-watt power supply.

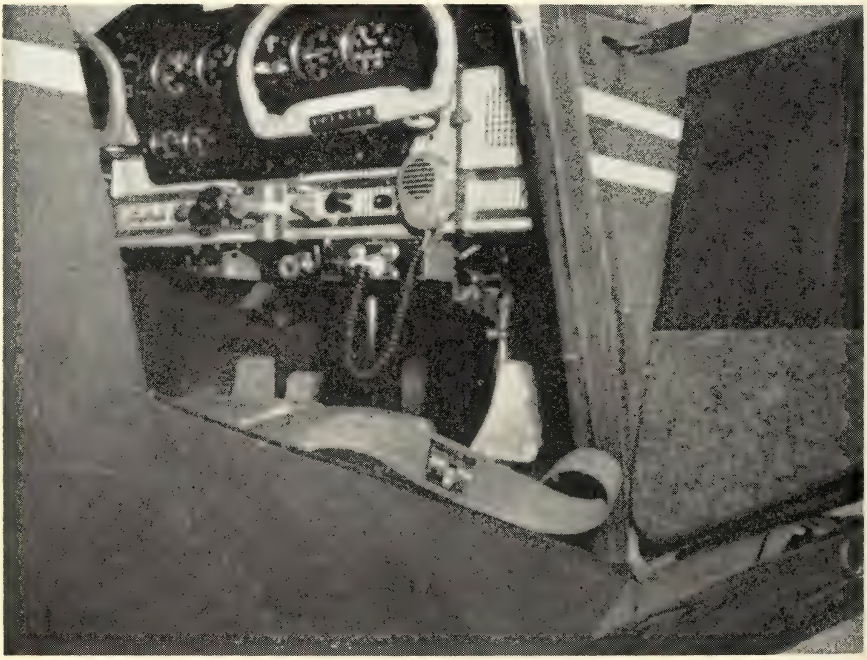


FIGURE 2.—Control head and microphone for FM radio mounted on instrument panel.

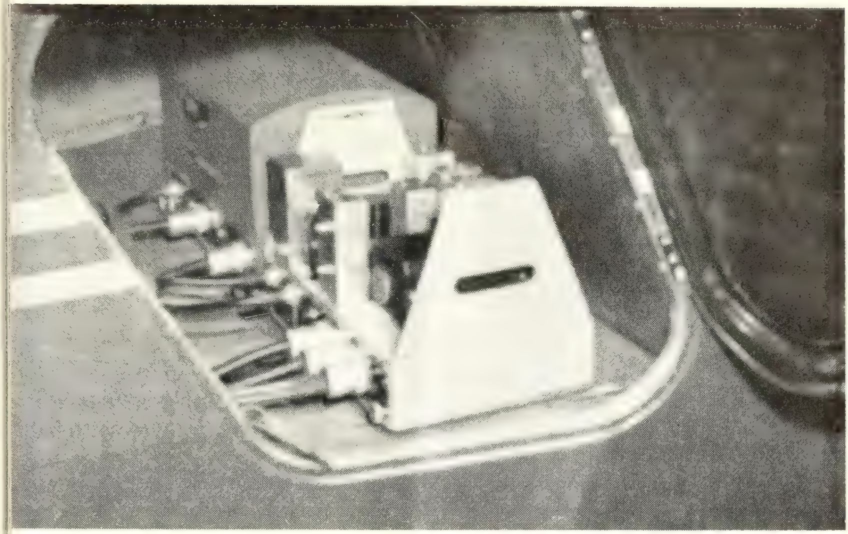


FIGURE 3.—FM radio installed in baggage compartment of airplane.

This radio provides the pilot communication with 154 other radio units. Of these units 110 are mobile, 5 are at district headquarters, and the rest are in fire towers.

It is not intended that airplanes will replace fire towers, but they will be used as aids to the towers and for patrolling our Ohio River drainage which is not covered by fire towers. Airplanes will also be used to detect fires during the winter months when the fire towers are not manned and the weather becomes mild enough for forest fires. The past two winters were very mild in West Virginia, and we had a number of fires in the southern counties. Covering this large area was quite a task for our one airplane.

It has been very difficult to determine the cost per fire for aerial detection. The Commission's airplane has cost about 5 dollars per hour to operate. This includes gas, oil, and maintenance. Hangar rent is not included because this is given to the State by the Kanawha County Court, which owns and operates the airport. The pilot does most of the maintenance, except major overhauls and relicensing of plane each year. The only way we have determined the cost per fire spotted is by adding the number of fires and illegal brush burnings reported and dividing this total into the cost of operation of the airplane.

The area covered by the airplane is also hard to determine for a number of reasons. If the pilot flies at an altitude of 6,000 or 7,000 feet above the terrain and the visibility is fair to good, he can spot a fire in a radius of 20 to 25 miles. Under these conditions and at a speed of 110 m.p.h., the airplane can cover a large area in an hour's time. Flying at higher altitudes is impractical because much of the time is spent climbing and descending to run fixes on the fires and to use the loud-speaker. Also the pilot has to be at a low altitude to help the radio car or truck find the fire, and to

report road conditions and any other information which may help in suppressing the fire.

The number of fires in a day's patrol also has a great deal to do with the amount of coverage. On days when many smokes are being seen the area covered is materially reduced because some time has to be devoted to each fire. For example, on one day of patrolling with a large number of smokes to investigate, the pilot covered 10 counties in 6 hours as compared to 25 counties in 6 hours on another day when only three fires were seen. The amount of coverage per hour can be increased by using a faster plane, which can still fly slow enough to use a loud-speaker efficiently, and also by the pilot becoming better acquainted with the area patrolled, thereby cutting down the time for running fixes.

Determining the coverage is still a problem for which we would appreciate any information or suggestions. The pilot has tried using a planned patrol. This works all right on days of few or no fires, but does not when a large number of smokes are being seen. More airplanes each covering a smaller area would probably be the answer.

We have only had an airplane on forest fire detection for the past 3 years, but are utilizing it more all the time. Any suggestions as to better or more efficient use of airplanes in this phase of forestry will be welcomed by the Conservation Commission of West Virginia, Division of Forestry, Charleston 5, W. Va.

Vibration of Plane Struts Dangerous

Fastening loud speakers to airplane wing struts may set up vibration of sufficient intensity to prove dangerous. The tendency of prolonged vibration to cause crystalization of metal is well known and since wing struts are designed in accordance with the capacity of specific metals to withstand tension, any change in a metal which would change its strength might result in failure.

The installation shown in the photograph was test flown by engineers of the C.A.A. and found to vibrate dangerously at all flying speeds, power on and power off.

As an alternative, the speaker was installed inside the fuselage immediately aft of the rear seat. The rim of the speaker is flush with the bottom of the fuselage and set at an angle which points the instrument at a spot on the ground around which the plane is flown while a message is being transmitted. This installation was approved by C.A.A.—O. A. ALDERMAN, *State Forester, Ohio Department of Natural Resources.*

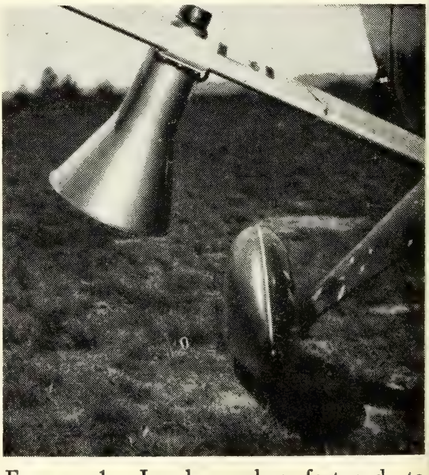


FIGURE 1.—Loud speaker fastened to wing strut of Stinson 150 Voyager.